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JUNE 1936

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DUSTSTORMS IN THE SOUTHWESTERN PLAINS AREA

By H. F. CHOUN

[Weather Bureau, Denver, Colo., April 1936]

Numerous articles, and photographs which apparently substantiate them, have in the recent past predicted that either large acreages of land in the dust-bowl area of the southwestern plains must be abandoned, or else continued depression and failure must be faced by those trying to combat the elements. This paper, while it will verify the seriousness and severity of soil erosion due to wind in the area shown in figure 1, will also show that total abandonment of the area is not imminent or necessary.

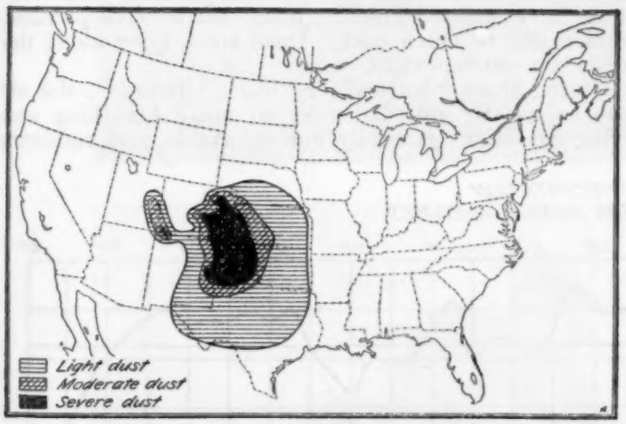

FIGURE 1.—Extent and intensity of duststorms over the southwestern plains during March 1936.

The topographic features of this section of the Great Plains area conform to the underlying rock formations. Valleys and undulating plains have been formed through erosion of the softer, lesser resisting beds. There are many miles of comparatively level country, as well as upland valleys and mesas, which comprise thousands of acres of fertile land that have been reclaimed by irrigation enterprises and improved farming methods.

The climate is very similar throughout the region. The general climatic features are: A low relative humidity; a large amount of sunshine; a light rainfall, confined largely to the warmer half of the year; a moderately high wind movement; and a large daily range in temperature. The wind movement is lowest near the western limits; and over the plains it increases toward the east. At Las Animas, Colo., the average hourly wind movement is 8.5 miles; at Dodge City, Kans., 10.2 miles; at Santa Fe, N. Mex., 7.8 miles, and at Amarillo, Tex., 12 miles. The velocities are greatest in spring, following the driest period of a normal year. The diurnal range in the wind movement is large, the velocities being generally high in the afternoon and dying down at night. Chinook winds prevail to a great extent throughout the area, causing a large daily range in temperature. Occasional dry spells, and periods of abnormally heavy precipitation, persist over periods of 2 or 3 years with resulting serious droughts and great variations in crop yields. The question of whether there has been any progressive or retrogressive change in the amount of precipitation since the Plains area was settled, has been the subject of much discussion. The examination of reliable precipitation records, some of which were begun more than 50 years ago, bears out the view that no appreciable permanent change has taken place that will greatly affect the normal. There has, however, been a gradual increase in temperature and a gradual decrease in precipitation for the past several years. Figure 3 shows the general rainfall trends at two long-record stations, Las Animas, Colo., and Dodge City, Kans., within the so-called dust bowl. This graph is based on the average annual amount of precipitation for these two stations, smoothed by 5-year moving averages. That is, the entry for each year on the graph shows the 5-year average for the two stations, up to and including that year. It will be noted that for the 5 years ending with 1894 the average was almost exactly the same as for the 5 years ending with 1935. In other words, similar droughts occurred at these two times.

The occupation of this Great Plains area for agricultural purposes began about 1885, when there was a migration of land seekers into the region. The settlers made their livelihood by crop farming, at which they succeeded fairly well for 3 or 4 years. Then came 3 "lean years"; 1894 was a year of complete crop failure, due to drought. In some parts of the plains region as many as 90 percent of the settlers left their farms. Following this recession in land settlement, a gradual healing over of the denuded fields by native grama-buffalo sod took place. The settlers who remained learned from experience how to cope more effectively with the unfavorable crop years and with drought. The next impetus to land settlement and crop farming was given by the high prices offered for agricultural products during and immediately following the World War. Promoters launched campaigns to get crop farmers instead of cattle raisers interested in the region, tractors and other labor-saving machinery were introduced, and grain farming was undertaken on a rather large scale. Reckless denuding by cultivation and overgrazing continued on this land, where rainfall at best is light. Ex-

perienced cattlemen knew the danger of overgrazing the plains, but the temptation of high prices led them to take the chance.

In the area where there is an urgent need for rain, shown in figure 2, an average of from 60 percent to less than 50 percent of the normal rainfall occurred during the 18-month period from September 1934 to March 1, 1936.

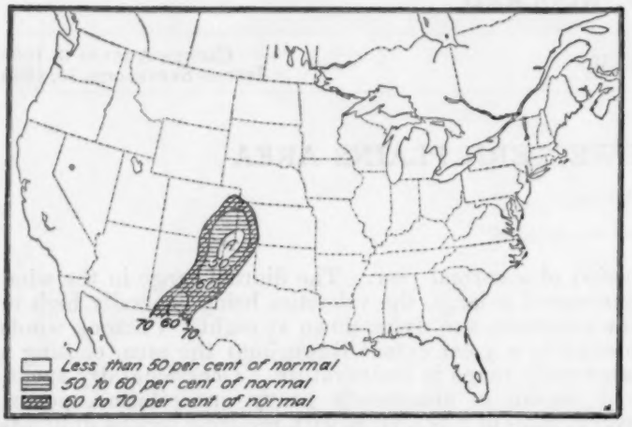

FIGURE 2.—Percentage of normal precipitation during the 18 months from September 1934 to February 1935, inclusive.

Abnormally high temperatures continued from June 1933 to August 1935, with but temporary relief during short periods. This prolonged period of warmth has never been equaled in the recorded climatological history of the area. The digging of wells and installation of pumping plants were resorted to in an effort to save small crops and obtain drinking water. The digging of these wells showed that the subsoil moisture was depleted to a great depth. The prolonged drought made it nearly impossible to secure stands of grain; and where stands were secured, not enough reserve moisture was available to meet the requirements of the plants for survival to maturity. Increased insect activity during this period also played an important part in the destruction of vegetation. A shortage of feed for cattle, and the poor condition of pastures generally, prompted farmers to take advantage of every opportunity to obtain feed; in desperate attempts to obtain forage, Russian thistle and weeds were harvested so closely that no protection was left to hold the soil, and great areas were exposed to the action of the wind.

During the spring months of 1935 loose topsoil from thousands of farms in the drought-stricken area was carried off by winds of high velocity, reducing visibility and causing hazardous driving and flying conditions. In the storms, sufficient static electricity was generated to render automobile ignition systems useless, and scores of motorists were temporarily stranded; when the storms abated, drivers found that their cars again functioned properly. The static electricity, produced by the friction among minute dust particles in the air, was so intense that distinct electrical shocks were received when one came in contact with any metal part of a car. Many resorted to the expedient of dragging chains and wires to ground the static accumulation and prevent short circuits. Cherry orchards in the rich agricultural section between Fort Collins and Loveland, Colo., suffered severely when the freshly plowed soil was swept away, leaving the roots of the trees bare. The topsoil was also blown from fields devoted to winter wheat and alfalfa, so that in many instances reseeding was necessary.

In Colorado the damage was greatest in southeastern counties, e. g., Kiowa, Prowers, Baca, eastern Bent, and Las Animas Counties, where the suffocating dust storms occurred frequently from March 12 to 25, 1935, bringing death to 6 persons and serious illness to more than 100 others. Sickness continued in this section, where lung congestion was reported to have been aggravated by the dust-laden air. In the more seriously affected areas, the dust lay from a few inches to more than 6 feet deep, and considerable livestock perished from starvation and suffocation. The following is quoted from a cooperative observer's report: "The dust has drifted into feed stacks and covered pastures until livestock have suffered greatly; many cattle have perished from eating so much dust. Dead stock lying along the roads is a common sight."

During these "dusters" or "black blizzards", the air was so heavily dust-laden as to make breathing and living conditions generally uncomfortable, and residents of the affected areas hung wet blankets over their doors and windows and covered their faces with wet cloths. Schools were closed temporarily in many localities as a measure of safety, and many ranch homes were deserted by their occupants. Visibility became so limited at times that artificial light was used during midday, while at other times the visibility was reduced to zero. During the height of some of these "blows", it became so dark that business was temporarily forced to be suspended, even when artificial light was used. Aviators reported dust present at altitudes of from 15,000 to 20,000 feet, and brisk winds carried the dust clouds far into the elevated regions east of the Continental Divide.

During the early afternoon of April 14, 1935, the most severe duststorm of the series that started on March 1 began moving across extreme western Kansas and eastern Colorado. The coppery-hued sky cast a brown shadow,

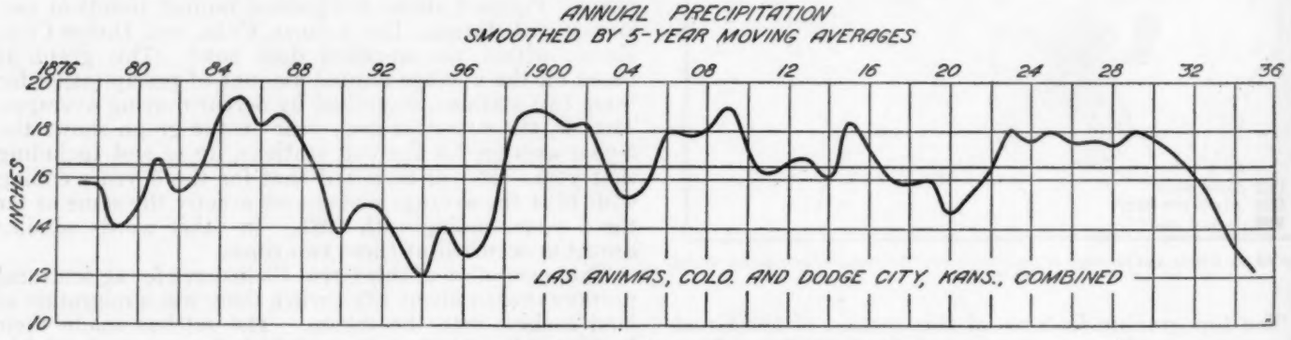

FIGURE 3.—Precipitation trends, Las Animas, Colo., and Dodge City, Kans.

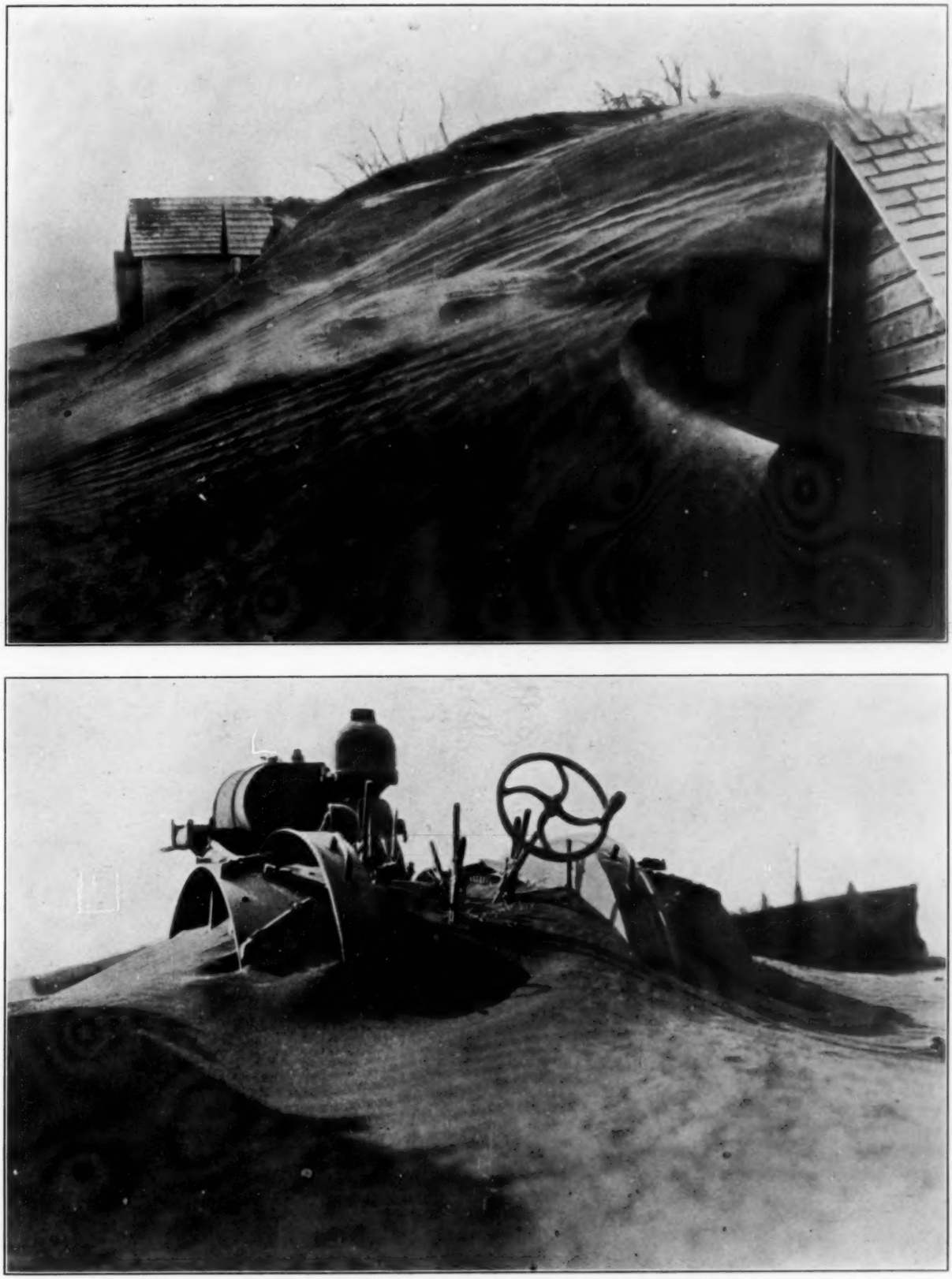

FIGURE 4.—Dust accumulation around farm buildings and farm machinery in the affected areas.

FIGURE 5.—Aerial view of the beginning of a duststorm over the prairie lands east of Denver. This photograph shows the action of northerly winds in removing topsoil. The clouds of dust were raised by southerly convectional air currents to elevations of approximately 16,000 feet as is evidenced in the background, capping the mountain range. Prevailing westerly winds carried some of this dust as far eastward as the Atlantic seaboard.

giving the scene a weird appearance. The storm struck Denver at 2 p. m. and blotted out the sun as it moved southward. Sand drifts were piled up that stopped trains and automobiles, grounded airplanes and enveloped regions little affected by previous storms. Homes and stores were filmed with a thick coating of the powdery dust.

Winds of gale force again were frequent over most of the area during the spring months of 1936. Crops, pastures, and ranges, already suffering from a lack of moisture and the duststorms of February, were further damaged by severe duststorms. On March 1, 1936, light dust began in east-central Colorado, and by the 4th the storm had extended from the Black Forest region in Colorado over the lower Arkansas River Valley into the Panhandles of Oklahoma and Texas. On the 10th moderate to heavy dust occurred in extreme southeastern Colorado and in the Oklahoma and Texas Panhandles, which reduced the visibility considerably in the lower part of the area. On that date, north and northeast winds, with velocities of 30 to 35 m. p. h., bore dust up the South Platte River Valley as far as the South Park region, reducing the visibility to "poor" over much of the area. Southeasterly winds bore clouds of dust which enveloped the entire region east of the 104th meridian in Colorado on the 11th. Dust continued intense on the 13th, and during the following two days practically the entire region east of the mountains was covered by the dust pall, reducing the visibility to from 500 yards to 1 mile in Colorado; to 4 miles in Curry County, New Mexico; and to 25 feet at Kenton, in the Oklahoma Panhandle, where daylight was turned to darkness. In this region, the dust clouds turned from a dark blackish color at the beginning to a yellowish red tinge. A driving wind accentuated the storm. A maximum velocity of 33 m. p. h. was reached at Pueblo on this date, and the air was filled with fine driving silt far into the foothills sections, reducing the visibility to 10 feet at Monument, on the main arterial highway between Denver and Pueblo, and making driving and flying conditions hazardous. The driving sand removed paint from automobiles, and pitted windshields.

Some areas of ungrazed grassland in the foothills were completely covered with the fine dust during the storm, and then uncovered by brisk winds a few hours later. In Baca County, Colo., the visibility was limited to one city block for 9 consecutive hours and to zero for 1 hour. Duststorms continued intense through the remainder of the month in extreme southeastern Colorado, southwestern Kansas, and the twin Panhandles, keeping Baca County in semidarkness for periods of from 3 to 24 hours each day. During the height of some of these blows, highway travel was paralyzed and electric-lighted show windows were not visible from a distance of 40 feet; while at times the raging "dusters" cut the visibility to zero, and pedestrians collided with one another in attempting to get about.

Reports from extreme southeastern Colorado and extreme southwestern Kansas on March 25 and 26 stated that the storm was the most severe and of the longest duration of any ever experienced in that region. On these dates the storm spread from extreme east-central New Mexico, across the Panhandles of Texas and Oklahoma, and covered practically the entire State of Oklahoma, reducing the visibility to 350 yards as far east as Vinita, and to 600 yards in the southeastern portion of that State. The clouds of whirling silt appeared russet, blue, orange, and black in succession.

On the 31st, the storm covered the entire region south of the fortieth parallel east of the mountains, far into the upper reaches of the Arkansas River and westward along the Colorado-New Mexico border to the San Juan and Dolores River valleys, where the heaviest dust in the history of those sections was reported. At Pueblo, the sky was turned to a saffron hue, and when the dust clouds settled, they brought darkness to the city. The clouds of whirling silt made living conditions generally uncomfortable in the affected areas. Veils of the copper-hued silt were observed over western counties; and snow flurries and rain, mingled with dust, brought mud showers in northeastern localities, in the San Juan Mountain region, and as far north as Columbine, Colorado. A phenomenal accumulation of muddy snow in the form of balls, the diameter of silver dollars, fell over some north-central districts of Colorado.

The data in table 1 were compiled with a view of detecting any progressive or retrogressive changes in duststorms of the area since they have become of proportions sufficiently great to affect human comfort. Data recorded by the Weather Bureau office at Amarillo, Tex., the only first order Weather Bureau station near the center of greatest activity, were chosen as the most reliable and complete for this purpose. Two years ago, the topsoil that blew in these regions was coarsely granular in structure; but due to its having been shifted back and forth, it is now as fine as face powder, and erodes at a lower wind velocity. This condition is especially noticeable in the Clovis, N. Mex., area. It is likewise noticeable that the wind can support and carry the topsoil to greater distances, as was evidenced during March 1936.

Road maintenance problems were not major engineering difficulties; but much trouble was experienced by, and most serious problems confronted, the highway departments during the dust periods. Snow fences running parallel with and about 100 feet north of the east-west highways were, in many areas, completely covered with dust drifts. These wooden picket fences were removed with portable hoists, and the drifts leveled by team or tractor-drawn blades. Drifts frequently filled road ditches and interfered with traffic on the highways. Following an inspection trip by automobile through southeastern Colorado, the writer found nearly a pint of sand and dust had accumulated in the oil-bath air filter of his car. Undoubtedly, automobiles not equipped with some sort of air filter, as a precaution against having dust enter the motor, suffered bearing trouble.

Northerly winds seem to be the most potent in respect to erosion, as they are of slightly greater velocity, colder, heavier, and have greater carrying power near the ground. This is evident from the appearance and size of dust drifts along fences and other obstructions and barriers. Yet southerly winds often are quite strong, with violent gusts; their work of erosion is notable, and they tend to carry the dust to great altitudes. Wind from the south usually reaches its maximum velocity between 2 p. m. and 5 p. m., the period of greatest frequency of soil erosion. Northerly winds appear to develop greatest velocities shortly after setting in and maintain them steadily until near the end of the period. The lapse rate within the air is a major factor in the extent to which dust is carried high aloft and transported long distances.

In response to inquiries sent into the affected areas, came reports of tillage practices which included examples both of effective and of careless forms of farm management. Fields which continued to lose topsoil are those where owners failed to learn the lesson taught during the summers of 1934 and 1935, that bare ground always blows if unprotected. Some farmers put in large acreages of nothing but beans, while others put in protective strips of

corn or feed crops, or plowed up ridges crosswise to the prevailing winds. These ridges serve a dual purpose. In addition to the ridges serving to minimize soil blowing, they tend to hold the moisture on the fields where it falls. In recent years, when the grain brought high prices, the majority of farmers in the panhandles of Texas and Oklahoma and in the vicinity of Clovis, N. Mex., raised livestock and row crops of corn, milo, maize, kafir, sorghums, and other fodders.

A few succeeded with wheat; others felt they could do likewise, and cultivated their grassy pastureland, forgot livestock and row crops, and drilled in every available acre to nothing but wheat. The region soon became known as the wheat empire of the Southwest. One farmer northeast of Dalhart, Tex., planted 7,000 acres (nearly 11 square miles) in wheat, while another farm which comprised 10,000 acres was planted with a like crop. Reports as of April 1, 1936, state that several hundred thousand acres of wheat in the twin panhandles and in the wheat districts of New Mexico and southwestern Kansas were either blown out or smothered with dust deposits during March. In extreme southeastern Colorado, 150,000 acres of wheat planted this year has been blown away.

Generally speaking, wind erosion takes place under extremely dry conditions with a wind velocity of 20 m. p. h. on all land which has been in cultivation 3 or more years. A seeder operates to pulverize and level off the top soil, thereby making it more susceptible to blowing and to the action of the full force of the wind. Most of the land that had been in continuous cultivation for several (5 or 6) years lost considerable topsoil. However, some lands that were in cultivation 5 or 6 years ago and then abandoned have been healed over by plant growth and have resisted erosion. Native buffalo sod does not erode from direct action of the wind, although in some places, next to an eroding field, it may yield to attrition. The sod may appear to be "blowing" sometimes, when in reality it is merely captured deposition that is moving off from the impact of the wind in a new direction. Effective forms of farm management would necessarily have to be adopted on a community basis, as an isolated farmer would not benefit if adjoining fields were tilled in a careless manner. The worst offender in allowing fields to become "blow spots" is the owner who lives in town or city and comes out to his farm only long enough to put in crops and harvest them. Seemingly, such owners are more careless; farmers who have to endure the dust if they allow it to rise are more careful and do more planning.

Geological history shows that wind laid the soil in these great grassland areas over centuries of time, and Nature healed the land by providing buffalo sod and other grasses to hold it there. Now that the native grasses have been disturbed, it is natural that the wind claims the soil. In summarizing the possibilities of prevention of soil erosion by the wind, it seems that proper use of the land is the answer. From the evidence that has been presented, it is believed that if we should reach a state of ratiocinative grace, and impartially consider the net results of dry farming west of the one hundredth meridian in the district referred to, where the land is subjected to the full force of the wind, it would be well to retire much of the dry land that now is in cultivation, encourage a return of the native grasses, and confine the use of farming implements to very selective spots. It is also evident that duststorms are not only an attendant of unavoidable drought, but also, in a large degree, a result of destruction of native sods. Careless methods have allowed the topsoil, which contains humus accumulated for centuries, to be blown away, evidence of the fact that restoration of the soil to its predust-era condition will take a considerable number of years. Abandonment of the land is not necessary, as good returns can be obtained by selective tilling of some of the area and by using the remainder for grazing purposes.

The thanks of the author are due to the Weather Bureau offices at Topeka, Oklahoma City, Houston, Amarillo, and Albuquerque for their generous cooperation in furnishing data.

TABLE 1.—*Duststorms at Amarillo, Tex.*

Date	Visibility	Prevailing wind direction during duststorm	Duration of dust storm	Duration of lowest visibility	Highest wind velocity during duststorm
Year, 1933	*Miles*		*Hours*	*Hours*	*M. p. h.*
Jan. 18	¼	W	8	2	45
Jan. 21–22	0	SW	14	1	60
Jan. 25	¼	W	6	1	36
Jan. 26	3	W	5	1	42
Jan. 31	3	NW	4	2	28
Feb. 1	½	W	3	1	42
Feb. 5	1	SW	15	3	39
Feb. 6	3	W	7	1	42
Feb. 18	¾	SW	11	4	40
Feb. 21	2	SW	8	2	42
Mar. 4–5	½	N	14	1	40
Mar. 5–6	¾	N	20	3	30
Mar. 6	3	N	5	3	33
Mar. 8	5	NE	2	2	36
Mar. 12	5	SW	2	1	32
Mar. 13	1	NW	10	3	38
Mar. 17	2	W	8	3	38
Mar. 18	0	NW	6	1	44
Mar. 19	0	N	13	3	48
Mar. 22	1½	NE	9	2	39
Mar. 24–25	1	NE	19	1	42
Mar. 30	1½	N	6	2	26
Mar. 31	6	NW	2	2	13
Apr. 1	½	N	13	6	48
Apr. 2–3	1	NE	34	5	30
Apr. 4	0	N	6	1	44
Apr. 5	2	N	10	3	46
Apr. 7	5	W	2	1	36
Apr. 8	1	W	4	1	34
Apr. 10	1	N	11	3	40
Apr. 12	1	SW	6	2	42
Apr. 13	0	N	18	6	50
Apr. 19	0	SW	11	1	60
Apr. 20	5	W	4	2	30
Apr. 21	1	NE	7	2	30
Apr. 29–30	0	SW	18	5	56
Apr. 30–May 1	1	W	20	5	42
May 1	1½	NE	8	1	26
May 2	6	S	2	2	24
May 3	1	NE	3	1	12
May 6	¾	W	8	1	45
May 8	1	W	11	4	40
May 9	¾	N	5	1	26
May 11	5	SW	3	1	30
May 12	2	SW	7	3	42
May 19	5	SW	2	1	30
May 22	½	W	10	3	44
May 28	½	NE	14	1	47
June 7	6	SW	5	5	40
June 12	1	NE	10	2	34
Aug. 13	2	E	2	1	32
Sept. 30	1½	N	6	1	32
Nov. 12	4	N	2	1	28
Nov. 23	1	N	6	1	30
Nov. 25	5	NE	5	1	40
Nov. 26	5	SW	12	1	38
Dec. 5	5	N	4	3	45
Dec. 14	1	W	9	4	40
Dec. 31	2	W	2	1	33
Year, 1934					
Jan. 2	1	N	4	1	38
Jan. 6	1	N	8	2	42
Jan. 12	2	N	2	1	30
Jan. 24	5	NE	3	3	51
Jan. 28	6	NE	2	2	30
Jan. 31	2	N	8	1	46
Feb. 1	3	SW	8	3	20
Feb. 3–4	2	E	8	3	36
Feb. 17–18	0	NW	27	2	61
Feb. 24	½		10	2	44
Mar. 7	1	N	4	1	32
Mar. 9	2	NE	9	1	44
Mar. 13	¼	NE	6	4	50
Mar. 14	4	E	3	1	16
Mar. 16	5	S	5	5	40
Mar. 17	0	N	16	1	46
Mar. 31	3	SW	8	4	40
Apr. 1–2	0	N	5	2	38
Apr. 2	¼	SW	12	2	41
Apr. 3	1	NE	15	2	18
Apr. 5	1	NE	2	1	46
Apr. 11	1½	NE	12	1	37

TABLE 1.—*Duststorms at Amarillo, Tex.*—Continued

Date	Visibility	Prevailing wind direction during duststorm	Duration of duststorm	Duration of lowest visibility	Highest wind velocity during duststorm
Year, 1934—Continued	*Miles*		*Hours*	*Hours*	*M. p. h.*
Apr. 12	2	NE	4	2	14
Apr. 13	3	SW	4	2	28
Apr. 14	4	NW	2	1	30
Apr. 22	2	E	6	2	26
Apr. 23	3	SW	11	7	18
Apr. 24	2	E	19	7	24
Apr. 25	5	S	5	3	30
Apr. 26	1	N	6	3	28
Apr. 27	2	NE	5	2	34
May 3	4	SW	2	1	35
May 4	2	NW	4	2	18
May 13	1	N	5	1	40
May 14	5	N	3	1	28
June 15	5	S	1	1	18
June 20	5	NW	5	3	17
June 22	6	SW	4	4	32
July 5	2	SW	8	1	20
Aug. 2	6	S	5	5	16
Sept. 2	½	NE	8	1	60
Sept. 5	5	NE	4	1	40
Sept. 6	6	NE	2	1	49
Sept. 20	3	NE	7	1	48
Sept. 22	¼	S	1	1	42
Sept. 25	6	SW	2	2	40
Oct. 8	5	NE	1	1	17
Oct. 15	2	S	8	3	44
Nov. 2	½	SW	11	1	44
Nov. 4	1	NW	8	2	46
Nov. 27	½	NW	14	2	36
Dec. 1	4	W	4	2	38
Dec. 2	3	NW	7	2	28
Dec. 6	1½	NE	1	1	26
Dec. 31	¾	N	4	4	52
Year, 1935					
Jan. 3	5	NE	7	5	27
Jan. 12	2	W	4	2	41
Jan. 12-13	2	NE	8	2	39
Jan. 16	¼	W	10	1	56
Jan. 17	5	SE	4	1	29
Jan. 19	6	SE	1	1	25
Jan. 20	4	N	2	1	26
Jan. 21	6	NE	1	1	19
Feb. 13	3	SW	6	2	40
Feb. 14	4	NW	1	1	24
Feb. 15	½	N	11	1	30
Feb. 16	6	N	2	2	34
Feb. 17	6	NE	1	1	8
Feb. 18	1½	W	7	3	15
Feb. 21	¾	W	12	2	42
Feb. 21-22	0	NE	11	1	46
Feb. 22	4	SW	3	1	7
Feb. 23-24-25	0	N	56	1	44
Feb. 27	6	SW	1	1	18
Feb. 28	1½	SW	9	2	34
Mar. 3	0	W	4	11	48

TABLE 1.—*Duststorms at Amarillo, Tex.*—Continued

Date	Visibility	Prevailing wind direction during duststorm	Duration of duststorm	Duration of lowest visibility	Highest wind velocity during duststorm
Year, 1935—Continued	*Miles*		*Hours*	*Hours*	*M. p. h.*
Mar. 4-5	0	W	18	1	52
Mar. 5	⅛	W	8	1	37
Mar. 6	½	N	4	1	44
Mar. 8	4	S	8	2	35
Mar. 13	5	NE	1	1	20
Mar. 15-16-17	0	S-SW-N	55	3	50
Mar. 18	¾	SW	1	1	38
Mar. 19	¼	N-SW	14	4	28
Mar. 20	¼	SW	8	1	44
Mar. 21	2	SW	5	1	30
Mar. 22	3	SW	1	1	28
Mar. 26	3	W	2	1	25
Mar. 27	0	NE	19	8	46
Mar. 28-29-30-31	0	SW to NE	83	6	36
Year, 1936					
Feb. 3	¼	N	10	1	38
Feb. 7-8	0	SW-NW	23	5	40
Feb. 9	1	SW-NW-NE	15	2	40
Feb. 12-13	1	W-N-N-E	21	2	35
Feb. 13-14	⅛	SW-W-NE	22	1	44
Feb. 14	5	SE	5	3	18
Feb. 15	2½	SE	3	2	30
Feb. 17	1	NE	8	2	30
Feb. 23	½	SW	12	2	38
Feb. 24	½	SW	8	3	44
Feb. 25	1	NW	7	1	10
Feb. 25	1½	W	4	1	32
Feb. 26	½	NW	8	1	20
Mar. 1	0	NE	4	1	40
Mar. 3	3	SW	4	1	20
Mar. 4	½	NE	10	1	38
Mar. 5	3	S	4	1	30
Mar. 10	0	NE	13	1	40
Mar. 12	4	SW	16	1	33
Mar. 13-14	0	E-SE-S	12	2	29
Mar. 14-15	¼	NE	7	1	30
Mar. 15-16	0	N	7	4	48
Mar. 16	1½	N	7	1	24
Mar. 17	3	SW	6	1	16
Mar. 17	1	SW	12	2	40
Mar. 19	0	NE	8	1	36
Mar. 21-22	0	S-SW	17	2	42
Mar. 22	0	SW	13	3	52
Mar. 23-24	0	SW-W	19	9	56
Mar. 24	1	SW	4	1	36
Mar. 25	0	SW-W	15	1	42
Mar. 26	¾	E-SE	14	1	28
Mar. 27	1¼	SE-SW	10	2	13
Mar. 28	1½	W	3	1	33
Mar. 29	1	W	6	2	27
Mar. 30	2	W	5	1	28
Mar. 30	0	NE	11	2	40
Mar. 31	1½	SE	8	1	38

WINTER AIR-MASS CONVERGENCE OVER THE NORTH PACIFIC [1]

By ROBERT W. RICHARDSON

[University of California, Berkeley, May 1936]

This paper is the result of a study of storm tracks in their relations to frontal zones and to the distribution of air masses over the North Pacific Ocean. Upon the completion of cyclone frequency maps, the question of the location of the Pacific polar front appeared to be significant; a comparison of the maps with Bjerknes' map of the principal fronts in the Northern Hemisphere [2] reveals discrepancies that can hardly be accounted for by mechanical errors or incomplete data. It is admitted that the frontal zone shifts its latitude with the seasons; the question dealt with here concerns only the mean position of the polar front during the winter.

Figure 1 is based on the map and figure [3] employed by the authors of Physikalische Hydrodynamik, and illustrates the application of their theory in establishing the position of the Pacific polar front in winter from the mean pressure map for February. The underlying principle is that a front is produced by a particular combination of air movements that may graphically be represented by stream lines and is termed a deformation field. A typical frontogenetic deformation field is illustrated in the inset in figure 1. Considering the stream lines to conform to gradient winds in the Northern Hemisphere, the distribution of pressure will be as indicated. If the deformation field is to produce a front, however, it must be superimposed on an appropriate temperature field. The isotherms of such a field are indicated by the broken lines—temperature decreasing toward the top of the diagram. The warm air entering the deformation field from below, and the cold air brought in from above, escape along the axis of extension to the left and to the right. It is only along the front to the right of the intersection of axes, where the direction of the gradient wind produced by the frontal solenoidal field is opposite to that of the wind in the warmer current, that the equilibrium of the atmosphere is disturbed, and wandering cyclones are generated.

If these principles are applied to the map of mean pressure for February, upon which the sea level temperature field for February [4] has been superimposed, it is to

[1] Presented before the Association of Pacific Coast Geographers, Los Angeles, Calif., June 27, 1935.

[2] Bjerknes, V., et al., Physikalische Hydrodynamik, Berlin, 1933, 708, fig. 130.

[3] Op. cit., 703, fig. 127; 706, fig. 130.

[4] Isotherms from Schott, G., Geographie des Indischen und Stillen Ozeans, Hamburg, 1935, plate VI.

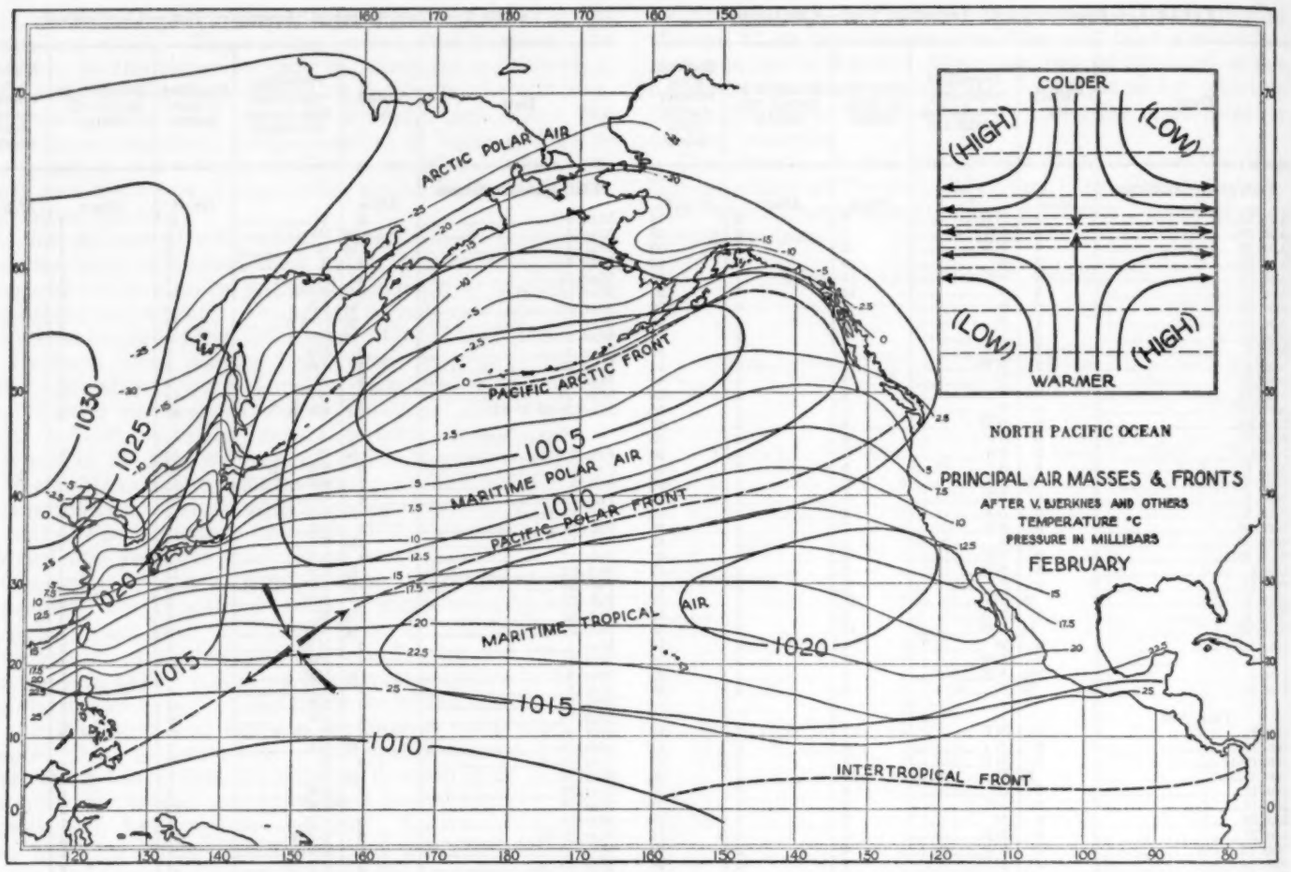

FIGURE 1.

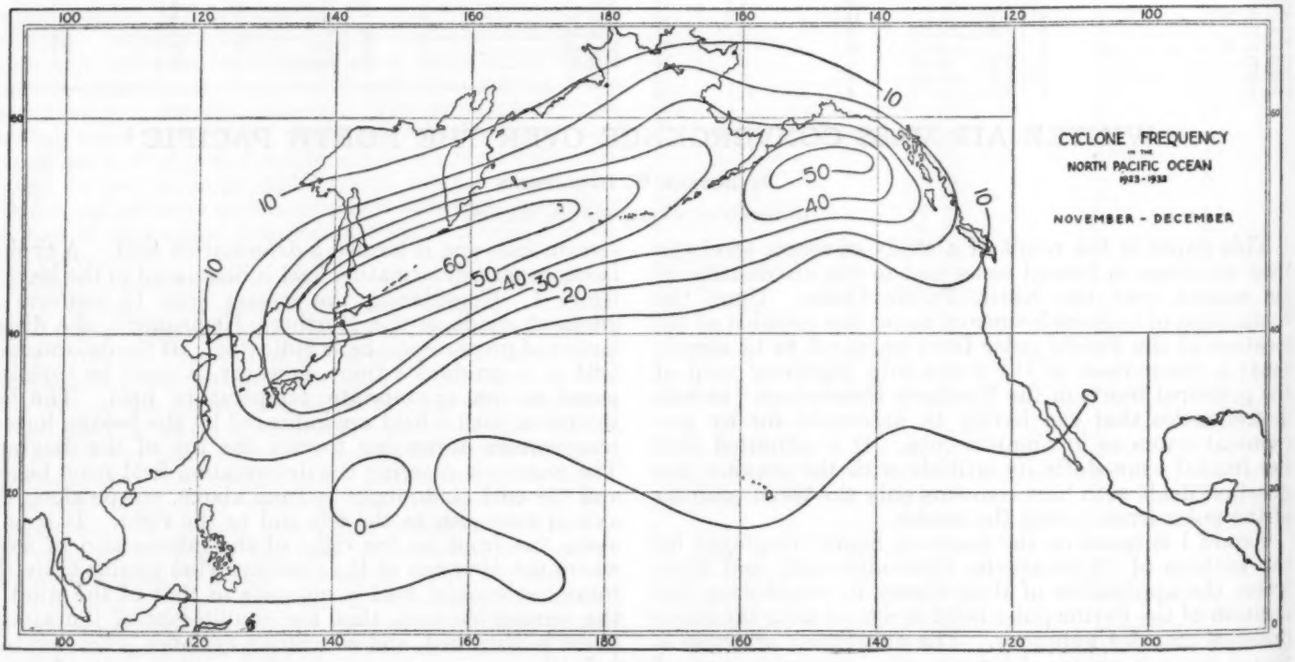

FIGURE 2.

be observed that both the distribution of pressure and the course of the mean isotherms support Bjerknes' thesis.

The air masses separated by the Pacific polar front are indicated as maritime polar air to the north, and maritime tropical air to the south. Polar continental air is thought of as coming along the isobars between the Asiatic HIGH and the Aleutian LOW, and being rendered unstable by its movement over the ocean surface.

The less questionable Pacific arctic front, which extends from the Aleutian Islands across the Gulf of Alaska, separates arctic polar air (polar continental air) from originally polar continental air that has circulated over the ocean and become maritime polar air. The explanation offered is that the coastal mountains cause the latter mass of air, which is moving from the southwest, to ascend, thereby forming a front between the maritime polar air aloft, and the denser arctic polar air at ground levels.

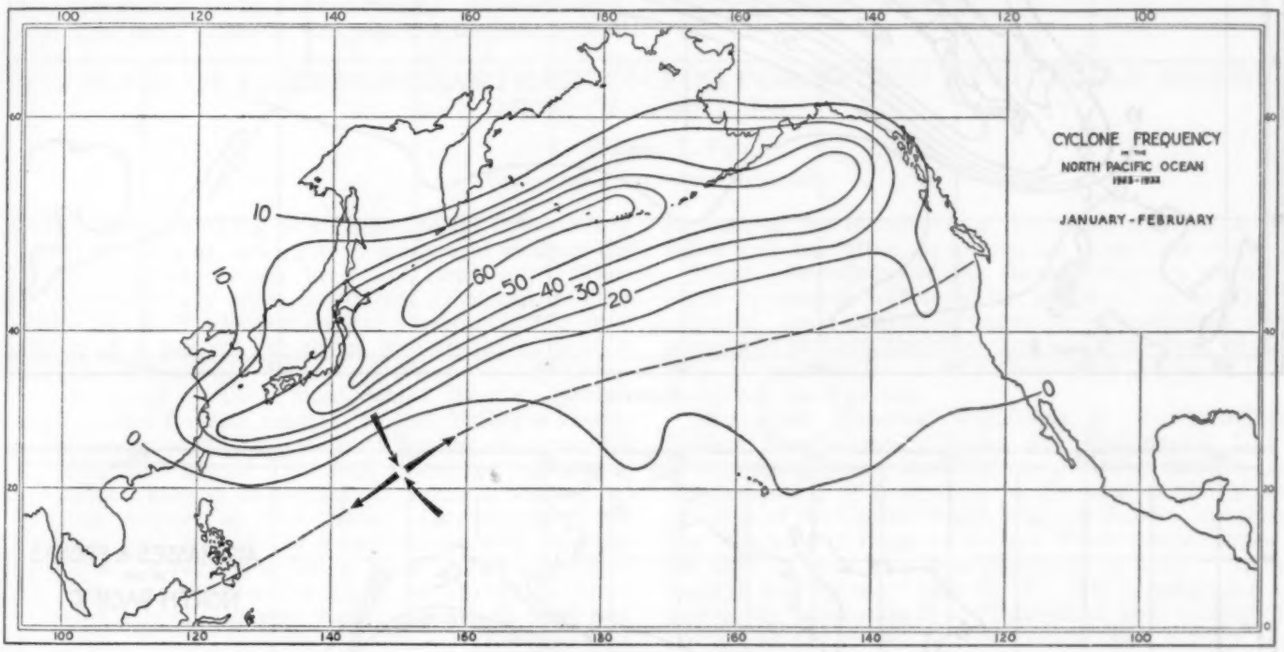

FIGURE 3.

The location of the Pacific polar front along the axis of extension of a deformation field indicated by maps of mean pressure does not agree with the indications of daily weather maps of the North Pacific. This contention is essentially based on the maps of frequency of cyclones (figs. 2, 3, and 4), on the ground that the axis of the region of greatest frequency indicates the mean position of the front. The isarithms on these maps represent total cyclonic frequency during the 10-year period ending with 1932. These frequencies were tabulated for bimonthly intervals, starting with January-February, and were plotted for each 5° square of latitude and longitude. The original data were obtained from the maps of cyclone tracks appearing in the Japanese "Daily Weather Charts of the North Pacific Ocean".[5]

For comparative purposes, the Bjerknes, polar front has been shown on the January-February map (fig. 3) in order to point out that the neutral point of the deformation field falls in an area registering no cyclone tracks during the decade of observation, while the front itself passes through a zone having fewer than 10 cyclones. Attention may also be called to the apparently independent zone of frontogenesis existing in the Gulf of Alaska. This is exceptionally well marked on the November-December map (fig. 2), and also on the map for March-April (fig. 4). The absence of a clear development of this zone on the January-February map may be attributed either to incomplete observations or to a thus far unaccounted-for diminution in frontal development at this time of the year. The March-April map is considered to be the last of the series that is representative of winter conditions. This conclusion is based on the examination of similar maps made for the 6 summer months (May to October, inclusive, not reproduced here). With the exception of the September-October map, which shows a fairly well developed zone of maximum frequency extending from Sakhalin to the Aleutian Islands, neither of the other maps displays any intelligible pattern.

Figure 5, depicting winter air masses and fronts in the North Pacific, is a graphic representation of the conclusions derived from examination of the maps of frequency of cyclones. In answer to the query regarding the location of the Pacific polar front, the dashed line extending from the East China Sea to the Bering Sea is the mean axis of maximum cyclone frequency, and represents, presumably, the mean winter position of the Pacific polar front. On the basis of frequency alone it is apparent that polar air moving off the Asiatic continent converges with air of tropical origin more frequently in the general region of the East China Sea than in any other place in the western North Pacific. In fact, in agreement with Mitchell's [6] earlier findings, Byers [7] states that 70 percent of the frontal systems of the North Pacific area have their origin in this region. Sekiguti [8] furnishes corrobo-

[5] Imperial Marine Observatory, Kobe, Japan ,Daily Weather Charts of the North Pacific Ocean. Appendices, 1923-32, inclusive.

[6] Mitchell, C. L., Cyclones and anticyclones of the northern hemisphere, Monthly Weather Review, vol. 58, pp. 1-22, 1930, particularly pp. 10, 13, and fig. 15, p. 14.

[7] Byers, H. R., The Air Masses of the North Pacific, Bull. Scripps Inst. Oceanography, Tech. Ser. v. 3, no. 14, 311-354, 1934.

[8] Sekiguti, R., et al., On the Characterization of Winter, Mem. Imp. Marine Obs, v. 2, no. 1, 1-7, 1925.

rative temperature data for that portion of the front which passes through or in the vicinity of the Japanese islands, in addition to identifying the air masses separated by the front. In this pioneer study it is pointed out that in the area comprising the Japanese archipelago

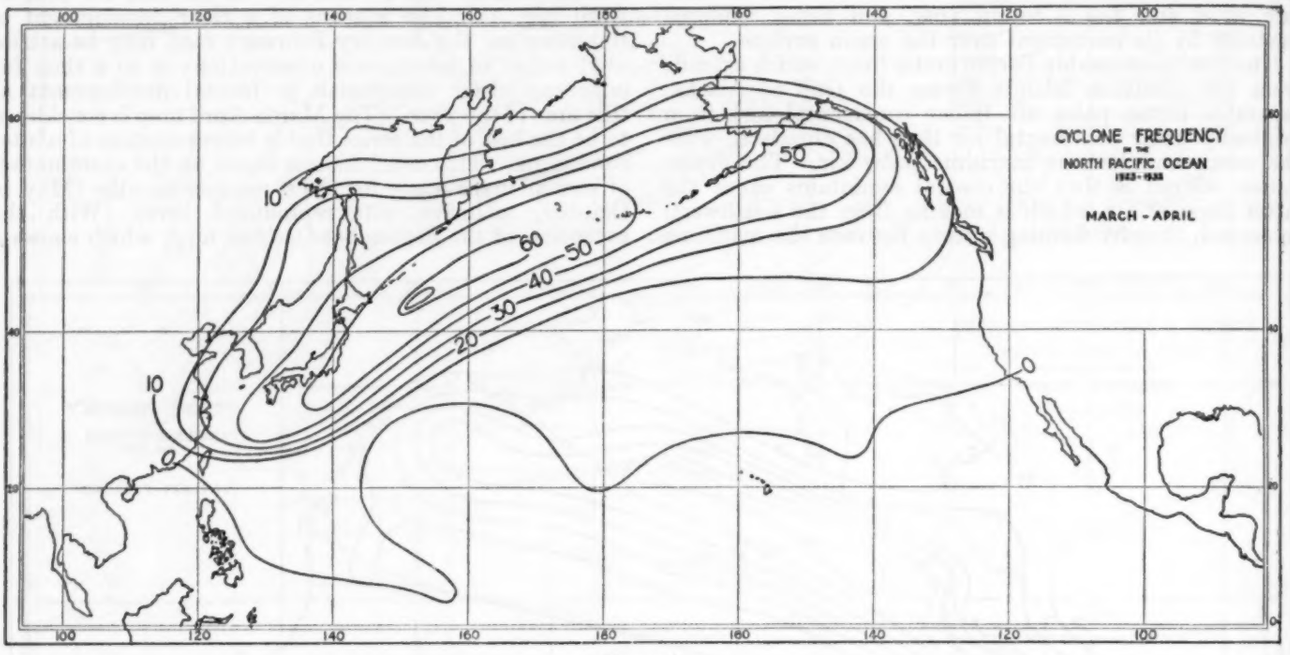

FIGURE 4.

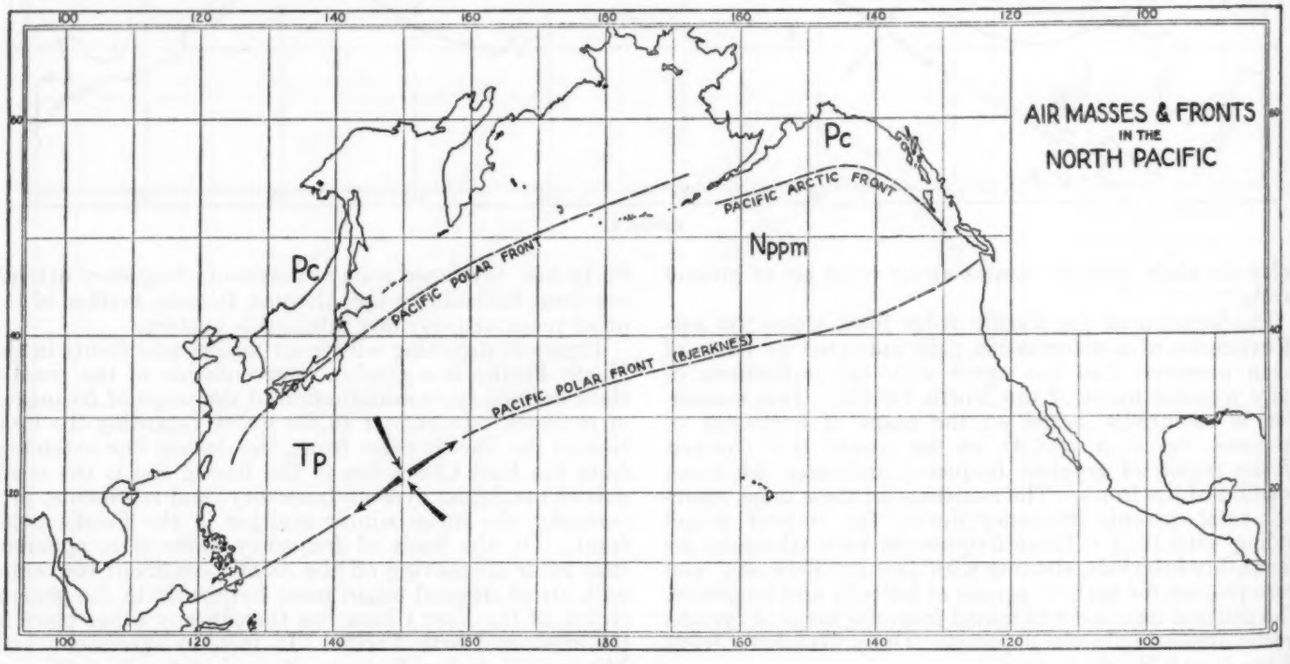

FIGURE 5.

more isothermal distribution to the south. The northern region, referred to as "subpolar", and the southern "subtemperate" region correspond, respectively, to the air masses designated in figure 5 as P_c and T_r, the latter of which may be thought of as N_{rr} in the vicinity of the Japanese islands. The polar continental air leaking out from the Asiatic monsoon HIGH is cold, consequently dense and dry; and before coming into contact with another air mass, does not cross a sufficient ocean surface to lose these characteristics or become modified. The

there are "two regions [that] can be reasonably regarded separate ones having different laws of temperature distribution." The line (polar front?) separating these two regions is identified by the comparatively steep temperature gradient to the north of the line in contrast to the

tropical air mass, on the other hand, is of marine origin, and is thus relatively warm, light, and near the saturation point.

Since no consistent temperature data exist for the area over the ocean, neither the location of the front nor the identity of the air masses can be predicted with the same degree of certainty. If, on the other hand, the mean position of the polar front is correct in its western reaches, there is no logical reason to assume that the front would be displaced equatorward in its eastern extension.

What has been attempted, and illustrated in figure 5, is essentially a revision of the Norwegian map on the ground that the establishment of a front from a deformation field, regardless of how clearly that field exists on the mean pressure map for February, is contrary to the facts revealed by actual observational data.

As previously mentioned, the discrepancies in the location of the Pacific Arctic front are slight. It is generally agreed that there exists in this region a distinct zone of frontogenesis and cyclonic degeneration. The explanation of this seeming paradox is that cyclones which are dying out after occlusion are often regenerated when fresh air masses are brought into them. The mean position of this front has been derived in the same manner as that of the Pacific polar front. The results thus obtained were checked with Werenskiold's [9] maps of mean monthly air transport, and strong agreement was found to exist between his lines of air convergence and the mean path of storms. The designations of the air masses (fig. 5) were derived principally from the synoptic weather maps of the California Institute of Technology and from Byers' [10] paper. According to these sources of information it is inferred that polar continental air, flowing out through the larger river valleys of Alaska, converges with N_{PPM} or N_{PC} air which has crossed the North Pacific.

[9] Werenskiold, W., Mean Monthly Air Transport Over the North Pacific Ocean, Geofysiske Publikationer, v. 2, no. 9, 1922.
[10] Op. cit., 322.

INFLUENCE OF LAKE PONCHARTRAIN ON FOG FORMATION AT SHUSHAN AIRPORT, NEW ORLEANS, LA.

By GEORGE V. FISH

[Weather Bureau, New Orleans, March 1936]

The importance of fog as a hazard to the operation of aircraft has been an incentive to study and analyze the various conditions which favor its formation. These studies, particularly those by Willett (Synoptic Studies in Fog, M. I. T. Meteorological Papers, 1930), have added much to current knowledge, and are the basis upon which the increasingly accurate forecasts of fog conditions are made by the United States Weather Bureau airway district forecast centers; to add further a knowledge of factors which have a direct bearing on particular local situations should prove of value to forecasters, particularly where an important air terminal is involved.

Shushan Airport, at New Orleans, La., is constructed on dredged land, inclosed by a concrete sea wall, on what formerly was a portion of the bottom of Lake Ponchartrain. The airport extends out into the lake in the shape of a blunt arrowhead, with facilities for both land and sea planes. The fill was completed to an average height of approximately 6 feet above water level. Lake Ponchartrain is classified as salt water; there is often a definite tidal influx which, however, is probably more than counterbalanced by the outflow from numerous fresh-water bayous which empty into Ponchartrain, so that the introduction of warm water from the Gulf of Mexico is confined to a very small section.

At its widest point, in a north-south direction, Lake Ponchartrain is about 25 miles across; roughly pear-shaped, it is approximately 40 miles along the east-west axis. Shushan Airport is on the south shore of the lake, near the point where it is widest. To the eastward, Lake Ponchartrain empties into Lake Borgne, another body of salt water, which is influenced to a greater extent by tides from the Gulf of Mexico.

The surrounding terrain is level delta land for many miles, not varying more than a few feet in elevation except for the levee works along the river and canals. The only impediments to the free flow of air along the level surface from all directions are the comparatively narrow strip of timber to the southeast and the city of New Orleans to the southwest. To the northwest, north, and northeast, nothing bars the free flow of air from off the lake. It is because of this circumstance that rapid changes in visibility and, less often, in ceiling, are sometimes observed.

From a knowledge of the changes that are known to occur in oceanic surface water temperatures, it may be assumed that marked changes in temperature occur seasonally in Lake Ponchartrain, and that these changes may sometimes be greatly intensified during a comparatively brief period.

McDonald (Seasonal Variations in North Atlantic Surface Temperatures, Trans. Am. Geophysical Union, 1935), using some material compiled by Schott, and supplementing it from data in the files of the Marine Division of the United States Weather Bureau, has shown that the annual range of surface water temperatures in the Gulf of Mexico in close proximity to Lake Pontchartrain is slightly more than 20° F. His investigation led him to the conclusion that "Intensified local cooling of a portion of the ocean surface occurs more readily than local warming."

If we may apply this conclusion here, which appears reasonable, and make further allowance for increased cooling due to closer proximity to the sources of extremely cold polar air, and for the fact that little if any warmer water is introduced by tidal action, we may assume that the surface waters of Lake Pontchartrain cool very rapidly with the coming of the winter season; and after a particularly severe cold wave, they may be further cooled, until a large difference in temperature exists between a mass of warm moist air advancing inland from the Gulf of Mexico, and the surface of Lake Pontchartrain.

The change from cold continental air to warm Gulf air usually is rapid. Since the surface waters of the lake respond more quickly to cooling processes than to warming, the difference in temperature between the water surface and the warm air mass will not be appreciably diminished during the average time required for translation of warm-air masses across the lake surface. During the period of translation, surface cooling of the air mass takes place, and surface fog over the lake normally results.

The formation of this surface fog may partially explain why surface cooling takes place more readily than surface

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warming; the formation of the surface fog largely prevents warming by insolation. The condition, by observation, tends to persist as long as the warm-air mass overlies the water, which may be only a matter of a few hours but can, under extremely stagnant conditions, persist for a day or more.

The layer of fog tends to disappear as it reaches and passes over the airport; but it can become a real hazard to the landing of aircraft when it is particularly dense, under special conditions. It is not often that the winds drift the fog in over the airport, since the field is on the south shore and the fog is most likely to form while southerly winds prevail; but when there is little pressure gradient, variable winds due to local temperature differences between the cold water and the warmer adjacent land may cause a slow landward drift to set in, which brings the fog over the airport.

When the wind is fresh, fog is not observed; with a moderate to fresh wind it may form, but seldom is a hazard, since at such times the circulation is so well controlled by pressure gradient that local effects are overcome. With light to moderate winds, the fog is almost invariably present over the lake during otherwise favorable conditions, appearing to an observer as a whitish gray roll of vapor at a distance that varies with (1) the wind velocity; (2) the moisture content of the overlying air mass; (3) the difference in temperature between the latter and the water surface.

The depth of the fog varies from a few feet, when it is barely distinguishable, to probably more than 100 feet under extreme conditions. At times the top of the layer presents a billowy appearance as the shifting variable winds bring about changes in the direction of drift, but the top of the layer is usually about level.

As the fog drifts in over the airport, if it persists long enough to reach the south side of the field (where the lake shore used to be) and passes out over the level country beyond, the barrier formed by the administration building and the two large hangars (one on each side of the administration building) gives rise to a peculiar condition to the south, with no fog over the area to the leeward of the buildings, while on either side the fog flows on with the surface currents drifting inland.

TROPICAL DISTURBANCES, JUNE 1936

By I. R. TANNEHILL

[Weather Bureau, Washington, July 1936]

June 11–17.—This disturbance, the first of the season, was in evidence in the radio reports on June 11; in the extreme northwestern Caribbean Sea, pressure was below normal with some indications of a cyclonic wind system in the Gulf of Honduras. The reports at hand do not show more definite cyclonic development until 8 p. m. E. S. T., of June 12, when the center was near the northeastern tip of Yucatan. The report from Cozumel Island gave pressure 29.56 inches, wind northwest, light. The disturbance was then moving toward the north-northwest. After passing into the Gulf of Mexico it turned to the northeastward.

The center crossed the Florida Gulf coast about 20 miles south of Fort Myers at 1 a. m., E. S. T., on June 15. During the 15th its course lay slightly south of east across Florida. The center passed directly over Miami with a lull in the wind from 8:03 a. m. to 8:23 a. m. of the 15th.

At 3 a.m., E. S. T., of June 16, the S. S. *Mayari*, at about 26° N., 73° W., reported wind west, force 8, lowest barometer reading (2 a.m.) 29.57 inches.

The center of the disturbance was located at about 30½° N., 69½° W., at 7 a.m. of the 16th. Twelve hours later it was a short distance northwest of Bermuda, where the barometer read 29.48 inches with wind south, force 8. The rate of progressive movement of the disturbance on the 16th and late on the 15th was rapid.

At no time in its history is this disturbance known to have been of hurricane intensity. The highest wind velocity at Miami was 39 miles an hour from the northeast. Wind velocities of 30 to 40 miles an hour were estimated at points elsewhere on the mainland of extreme southern Florida. No extensive damage was caused by the winds. There were torrential rains of 8 to 15 inches in some places in southern Florida, flooding highways and lowlands and causing much inconvenience and some damage. There was some loss of livestock from drowning. A Coast Guard airplane while in search of small boats, fell in Tampa Bay on the morning of June 15 and three Coast Guard employees in the plane lost their lives.

The first advisory message was issued at 9:30 p. m., E. S. T., on June 12 and timely advices were continued at frequent intervals thereafter until the disturbance had passed well to the northeastward of Bermuda on the 17th. Storm warnings were widely disseminated in southern and western Florida on the morning of the 14th, nearly 24 hours before the center of the disturbance crossed the southern part of the State.

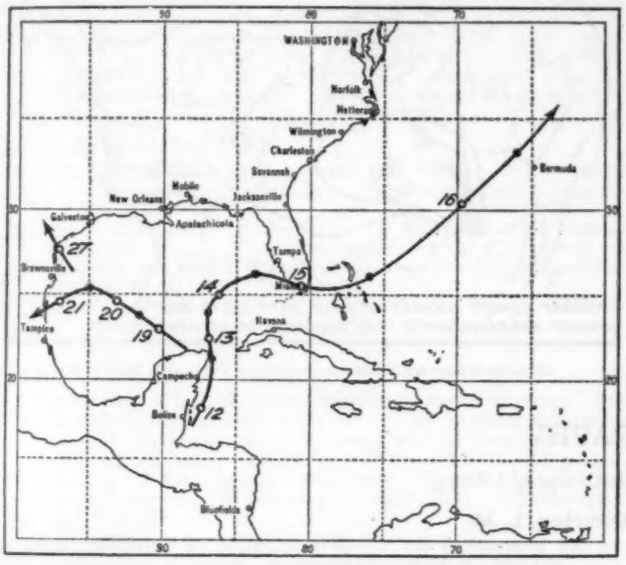
It is worthy of note that on June 8 and 9, just prior to the appearance of the disturbance in the Bay of Honduras, a tropical cyclone was reported in the Pacific Ocean off Guatemala. At 9:30 p. m. (local time) of the 8th the S. S. *Nordhval*, at about 13°45′ N., 94°30′ W., experienced increasing northeast winds. On the 9th when at approximately 13° N., 93° W., she reported east-southeast winds, force 9, barometer 29.18 inches (uncorrected). The wind then shifted to SE. and S., force 10, then to SSW., diminishing. This and other reports indicate that this cyclone was moving northeastward toward the coast of Guatemala on the 8th and 9th. While there are no further ship reports in the Pacific that connect this storm directly with the disturbance which appeared on the 11th in the Bay of Honduras yet there were heavy rains on the 9th and 01th in Yucatan, and British Honduras, with pressure and wind changes that indicate that this disturbance crossed to the Caribbean Sea.

June 18–21.—On June 18 squally weather was reported a short distance north of Yucatan without, however, any definite cyclonic circulation. Radio reports on the 19th indicated the presence of a tropical disturbance to the northwest of Yucatan. The disturbance moved in a northwesterly direction until the evening of June 20, when it was located approximately at 25° N., 95° W., after which it turned toward the southwest, crossing the Mexican coast between Brownsville and Tampico, probably near Sota la Marina.

There are no reports to indicate that this disturbance attained more than moderate intensity. The steamship *Louisiane* encountered the storm on the 20th and 21st and experienced wind force 8 from the north-northwest

with barometer reading 29.66 inches at 1 a. m., E. S. T., on June 21, at about 23°45′ N., 96°35′ W. The steamship *Arsa* at 1 p. m., E. S. T., on June 20, in latitude 25°20′ N., longitude 94° W. reported east wind, force 8, barometer 29.56 inches. At midnight (local time) of the 19th to 20th, the steamship *Cayo Mambi* near 25° N., 90° W. had wind east, force 8, barometer 29.68.

The first advisory was issued at 10 p. m., E. S. T., on June 19. Advices were continued at 6-hour intervals thereafter until the disturbance moved inland. During the 20th, storm warnings were hoisted on the Texas coast from Matagorda Bay to Brownsville. Special precautionary advices were issued because of the likelihood of many persons visiting islands and other exposed places along the coast during the week end. Although tides were somewhat above normal, the change in the path of the disturbance resulted in less severe conditions than had been anticipated.



June 26–27.—A tropical storm of small diameter appears to have developed near the coast between Brownsville and Corpus Christi on the night of June 26 to 27. The first indication of the disturbance was a rapid increase in the velocity of the wind from north by east at the Port Aransas Coast Guard station about 8 a. m., E. S. T. Pressure at that time was approximately 29.70 inches. By 9:45 a. m. the wind had reached an estimated velocity of 80 miles an hour from west-northwest. Lowest pressure was 29.32 inches at 10 a. m. Thereafter the barometer rose rapidly to 29.86 inches at noon. The following is quoted from the report of the official in charge of the Weather Bureau Office at Corpus Christi:

The calm center of the storm passed Aransas Pass between 11:15 a. m., and 11:30 a. m., (90th meridian time) and wind velocities from the NW. decreased from 80 m. p. h. to 15 m. p. h. within a few minutes, then increased to about 60 m. p. h. from the west. However, the wind soon decreased rapidly and the storm was practically over at noon. The calm period lasted about 15 minutes at Aransas Pass. A quiet period occurred at Corpus Christi about noon. The clouds broke rapidly, and the sun shone for a few minutes, and the rain almost ceased. Wind velocities decreased from 36 m. p. h. at noon to 12 m. p. h. at 12:07 p. m., then increased rapidly to 26 m. p. h. at 12:15 p. m., and to 30 m. p. h. at 12:24 p. m. After that, except for a rather heavy shower at 12:30 p. m., and fresh to strong gusts of wind, the wind decreased to eight m. p. h. at 2 p. m. The rain ended at 1 p. m.

From Port Aransas the storm moved northwestward over the southern portions of Aransas, Refugio, and Bee Counties and into Live Oak County, with diminishing force. Its further movement to the vicinity of Eagle Pass was evidenced only by heavy to excessive rain.

No deaths or injuries were reported. Damage occurred chiefly in the area surrounding Corpus Christi Bay. Total damage was estimated at $550,000, mostly to oil-refining property. There were severe crop losses in San Patricio County and in the extreme eastern portion of Nueces County.

Small craft warnings were hoisted in the Corpus Christi area at 9:15 a. m., C. S. T., of the 27th, northwest storm warnings at 9:40 a. m., C. S. T.; hurricane warnings from Corpus Christi to Matagorda Bay were ordered at 10:30 a. m., C. S. T.

The following is taken from a description of experiences in this storm by Leon Davis, master of the fishing vessel *Sea Gull:*

The *Sea Gull* left Port Aransas Friday morning June 26th for the snapper banks. Having reached a point 51 miles E. 1–2 N. from Port Aransas she anchored, the crew preparing to fish. The sea at that time was smooth, except for some choppiness, frequently occurring in the Gulf. A few cu. nb. appeared, all having rainbows at the top. About 9:30 p. m. the wind began to increase to a fresh breeze from the south; soon "scud" clouds appeared, with dashes of rain. This continued until 11 p. m., when the wind became a strong gale backing to east, and rain became steady and heavier. A whole gale was blowing at 2 a. m., with torrential rain, and between that time and 4 a. m. hurricane winds occurred, the direction E. and ESE., backing still farther to ENE. shortly after 4 a. m. The wind lulled somewhat after this, but continued to blow a whole gale most of the time. Hurricane winds again blew about 7 a. m. mostly E. and ENE. These hurricane winds continued, with some periods of intermission, until about 9 a. m. when the calm center reached the vessel. Suddenly the wind died down, the sun shone brightly, and the rain ceased. For a space of about a mile and a half, a clear circular area prevailed, the dense curtain of rain being seen all around the edge of the circle, and the roar of the wind being heard in the distance. Inside this clear circle the air was oppressive, and foul, with an odor like escaping gas; hot and cold puffs of wind blew alternately; there was a disagreeable feeling, like a scarcity of fresh air. Thousands of birds, both land and sea birds, milled about in this circle; also swarms of butterflies, and moths. Some of the birds fell exhausted on the deck of the boat. The barometer in this circle read 29 inches (29.16 inches, corrected). The heaviest seas of the storm occurred just before entering the center, and were as heavy as ever experienced by this crew in the Gulf of Mexico. After about 15 or 20 minutes the other side of the storm raged, winds now blowing from the W., WNW., NW., SW., and finally S. The storm died down with remarkable suddenness after the center passed, and by noon the storm was over, except for excessive roughness of the sea, which lasted all afternoon, and into the night, while the vessel was homeward bound. The wind and waves removed the paint from the hull of the *Sea Gull.* She almost capsized several times, only skillful handling preventing it. The maximum velocity occurred about 4 a. m., estimated 80 to 85 m. p. h. After the center passed wind did not exceed 70 m. p. h.

DUSTSTORMS IN THE UNITED STATES, JUNE 1936

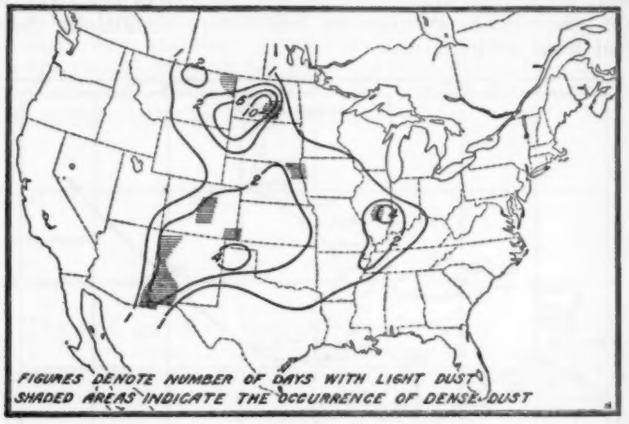
By J. P. KOHLER

Duststorms were somewhat more frequent, but less severe, in June than in the preceding month. The increases in number of duststorms are directly attributable to subnormal precipitation. Percentages of normal rainfall, given by preliminary but rather complete records, support this contention. The Dakotas, Minnesota, Kansas, Tennessee, and Indiana had less than 40 percent, and Iowa, Nebraska, Oklahoma, and Texas 60 percent or less, of the normal monthly rainfall.

Comparison of the accompanying chart with that for May brings out several notable differences. The eastern boundary of the dust area receded from western Pennsylvania to the extreme western portion of Ohio; Pennsylvania received approximately 94 percent of normal rainfall. Similarly the northwestern limits migrated toward the interior because of above normal precipitation over the States of Idaho and Wyoming. Further, three maxima of light dust were centered in the following sections: North Dakota and southeastern Montana; central and southern Illinois; Oklahoma, New Mexico, and portions of adjoining States. Areas of dense dust, delineated by cross-hatch lines, are small and widely scattered—the direct consequence of weak cyclonic movement during the summer months.

Duststorms effected no material damage to crops, partly because of advanced deterioration due to drought conditions and the weak character of the duststorms. However, in several instances, dense duststorms attained sufficient force to cause discomfort to inhabitants. On the 26th, Sioux City, Iowa, had a duststorm of considerable severity. The storm approached from the northwest, visibility was reduced to 200 feet for a period of 10 minutes, and the wind maintained a velocity of 67 miles per hour from northwest for a period of 5 minutes. One and twenty-three hundredths inches of rain was recorded at the Weather Bureau Station. Damage was confined mostly to windows and trees. A dense duststorm on the 12th in northeastern Montana reduced horizontal visibility to nearly zero and effected considerable soil erosion.

There were no reports of loss of life due to duststorms in the month of June.



Number of days with duststorms or dusty conditions, June 1936.

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING FEBRUARY 1936

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1935, REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged considerably above normal at all three Weather Bureau stations.

Table 2 shows a deficiency in the total solar and sky radiation at New York, Fresno, Twin Falls, Miami, Blue Hill, and Friday Harbor, and an excess at all other stations. That is, the northeastern, southern, and far western sections of the country received less than average sunshine during the month, while the central portions, or those areas suffering from drought conditions, averaged considerably more than normal in radiation receipt.

Two polarization observations obtained at Washington gave a mean of 61 percent, with the greater—63 percent—on the 25th. At Madison, observations obtained on 3 days give a mean of 63.8 percent with a maximum of 66 percent on the 11th. All of these values are above the corresponding June normals.

TABLE 1.—*Solar radiation intensities during June 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 2	10.97					1.16					6.93
June 5	9.47				1.15	1.30					7.87
June 11	9.83					1.34					8.81
June 15	17.37					1.39	1.01				16.79
June 16	10.97					1.30					11.38
June 17	17.86					1.22					19.23
June 25	10.59	0.83	0.95	1.08	1.23	1.41					9.14
Means		.83	.95	1.08	1.19	1.30	1.01				
Departures		+.24	+.27	+.30	+.25	+.05	+.09				

TABLE 1.—*Solar radiation intensities during June 1936*—Cont'd.

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 3	7.29		0.94	1.09	1.36						7.29
June 4	7.29	0.86	.94	1.09	1.23						6.76
June 11	7.29	.97	1.10	1.25	1.34	1.49					7.87
June 12	8.81		.88	1.05	1.22	1.50					7.87
June 19	9.47		.80	1.01	1.18	1.32					12.24
June 20	10.97		.80	1.01	1.18	1.32					9.47
June 23	7.29	.79	.90	1.04							7.87
June 24	7.87		.92	1.01							11.38
June 26	12.24					1.26					14.10
Means		.87	.91	1.07	1.26	1.42					
Departures		+.11	+.05	+.09	+.22	+.09					

LINCOLN, NEBR.

June 2	8.48					1.50	1.26	1.08	0.90	0.77	5.36
June 6	11.38				1.25						11.38
June 10	7.87						1.32	1.12	1.01	.91	7.87
June 11	8.18						1.24	1.08	.88	.70	7.87
June 12	9.14		1.00	1.13	1.30			.97	.81	.68	8.48
June 16	13.13	0.63	.78	.92	1.13						8.81
June 17	14.10	.88	1.00	1.11	1.30	1.53	1.13	.93	.84	.75	9.14
June 18	9.14	.76	.86	.99	1.18	1.40	1.14	.84	.66	.55	11.38
June 22	7.57								.80	.64	9.83
June 23	7.87	.76	.86	.99	1.18	1.40					8.81
June 24	8.48	.90	.98	1.09	1.30	1.50	1.23	1.02	.93	.78	7.57
June 26	8.18		.54	.69	.94						10.21
June 27	15.11	.65	.79	.95	1.16	1.40					13.61
Means		.76	.86	.99	1.21	1.47	1.22	1.01	.85	.72	
Departures		.00	+.07	+.05	+.10	+.11	+.11	+.09	+.06	+.04	

BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

June 1	8.8				0.92	1.14					9.6
June 2	12.3					1.21	0.91				9.9
June 3	15.3					1.06	.88	0.72			16.4
June 5	8.2					1.32	1.04				8.6
June 6	8.2				1.11	1.40	1.13	.91			9.2
June 7	10.7			1.21	1.33	1.27	1.16	1.11			12.8
June 8	13.2					1.27	.98				14.3
June 9	12.3					1.34	1.13				13.7
June 10	11.5					1.26					13.2
June 16	9.9				.94	1.40	1.26				8.8
June 17	7.1				1.17	1.21					8.8
June 20	15.3							.65			15.8
June 22	6.1			1.12	1.28	1.45	1.22	.90			5.8
June 23	8.6				.97	1.14	1.29				8.6
June 25	9.6			1.07	1.24	1.32	1.01	.72			9.9
June 28	13.2							.81			10.7
June 29	7.6					1.36					7.9
June 30	7.6					1.38					7.1
Means				1.13	1.12	1.28	1.09	.83			

* Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca	San Juan
	Gram-calories per square centimeter																
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
June 3	499	478	560	557	580	632	603	587	455	714	522	678	632	661	495	484	482
June 10	531	638	699	624	297	641	472	571	595	517	512	774	649	331	452	501	506
June 17	496	544	710	557	470	711	621	410	657	565	312	765	623	571	689	587	520
June 24*	554	510	681	500	358	758	488	435	659	635	392	717	626	515	660	503	546
	Departures from weekly normals																
June 3	+4	−32	+10	+113	+152	−16		+118	+3		−4	+185	+157	+155	−43	−6	
June 10	+32	+131	+153	+173	−138	−60		+69	−42		+31	+272	+48	−181	−167	+82	
June 17	+2	+21	+134	+93	+36	−10		−89	−41		−147	+293	+9	+25	+71	+82	
June 24	+23	−22	+78	+63	−92	+30		−39	+3		−123	+261	+13	−65	+50	−17	
	Accumulated departures on July 1																
	+2,191	+2,170	+3,444	+7,945	+4,690	+2,947		+448	−203		−4,522	+13,902	+1,246	−504	+170	+490	

* 8-day means. (Leap year.)

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during June 1936, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$ (Percentage of solar constant)	$\frac{I_{w=0}-I_m}{1.94}$ (Percentage of solar constant)	w	Air-mass type
June 5, 1936	° ′	m	gr. cal.	gr. cal.	gr. cal.						mm	
0:40 p. m.	72 04	1.05	1.317	1.061	0.857	0.100	0.096	0.098	78.2	8.0	5.2	N_{PC}, S aloft.
0:48 p. m.	71 12	1.05	1.295	1.059	.854	.110	.094	.102	77.2	8.2	5.5	
June 15, 1936												
0:16 a. m.	74 00	1.05	1.362	1.112	.899	.098	.070	.084	79.5	7.0	3.7	N_P, S aloft.
0:08 a. m.	74 04	1.05	1.372	1.113	.900	.090	.072	.081	79.9	6.8	3.5	
June 16, 1936												
0:52 p. m.	70 56	1.06	1.241	0.999	.804	.136	.144	.140	73.7	6.6	3.3	N_{PC}
1:00 p. m.	69 52	1.06	1.228	.996	.802	.132	.146	.139	73.9	7.5	4.6	
June 17, 1936												
0:16 a. m.	73 56	1.05	1.123	.910	.742	.156	.142	.149	77.7	13.1	36.0	N_{PC}, T_M aloft
0:08 a. m.	74 02	1.05	1.127	.912	.745	.155	.144	.150	77.5	12.8	35.0	

Atmospheric conditions during turbidity measurements

June 6. Temp. 13° C.; wind, NE. 10; polarization, 59.0 percent; blueness of sky, 5.
June 15. Temp. 17° C.; wind, NW. 12.
June 16. Temp. 16° C.; wind, NW. 10.
June 17. Temp. 15° C.; wind, SE. 10.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

June 1, 1936												
3:01 a. m.	31 14	1.61	1.016	0.720	0.587	0.131	0.149	0.140	63.7	8.7	6.9	N_{PC}, T_M aloft.
June 2, 1936												
3:02 p. m.	47 23	1.36	1.118	.736	.600	.108	.158	.133	69.2	9.8	8.1	T_M becoming S.
June 3, 1936												
1:46 a. m.	60 18	1.15	1.020	-------	.546	.170	-------	.170	68.0	13.9	12.8	T_M, S aloft.
3:08 p. m.	46 16	1.38	.890	.587	.470	.111	.112	.112	71.0	23.8	20.3	
June 5, 1936												
0:40 p. m.	68 39	1.08	1.305	.827	.663	.087	.138	.112	74.5	5.2	4.8	N_{PC}, S aloft.
3:58 p. m.	37 09	1.65	1.134	.708	.624	.065	.118	.102	69.7	9.5	7.2	
June 6, 1936												
4:11 a. m.	34 53	1.74	1.275	.855	.661	.008	.028	.018	83.0	15.3	11.1	
1:43 a. m.	60 59	1.14	1.402	.920	.717	.057	.024	.040	84.5	10.1	8.8	N_{PC}, S aloft.
0:25 p. m.	69 46	1.06	1.388	.899	.690	.030	.024	.027	87.3	13.6	13.0	
3:27 p. m.	43 00	1.46	1.275	.847	.673	.058	.070	.064	76.8	9.1	7.4	
June 7, 1936												
3:22 a. m.	43 55	1.44	1.298	.858	.682	.045	.065	.055	78.7	9.8	9.0	
1:41 a. m.	61 18	1.14	1.251	.815	.641	.074	.094	.084	78.1	11.7	10.8	N_{PC}, T_M+ S. aloft.
4:02 p. m.	34 32	1.76	1.177	.790	.615	.047	.072	.060	74.7	12.2	9.0	
June 8, 1936												
1:53 a. m.	60 34	1.14	1.164	.780	.621	.124	.135	.130	72.4	10.6	9.2	
0:44 p. m.	68 35	1.07	1.240	.799	.625	.069	.095	.082	79.7	13.4	12.2	T_M.
4:04 p. m.	36 39	1.67	1.067	.710	.563	.079	.101	.090	70.2	13.6	10.4	
June 9, 1936												
2:44 p. m.	50 58	1.28	1.272	.828	.643	.146	.075	.110	72.9	5.3	4.5	
4:42 p. m.	29 19	2.04	1.126	.724	.607	.049	.141	.095	65.6	5.8	3.9	N_{PC}.
June 16, 1936												
3:38 a. m.	41 21	1.51	1.140	.749	.605	.079	.120	.100	71.0	10.2	8.1	
0:53 a. m.	68 10	1.08	1.356	.860	.696	.067	.145	.106	77.3	8.1	4.4	N_{PC}.
3:14 p. m.	45 38	1.39	1.359	.878	.705	.029	.075	.052	79.9	7.6	6.2	
3:31 p. m.	42 44	1.47	1.340	.865	.698	.029	.062	.046	80.0	8.7	6.9	
June 17, 1936												
4:21 a. m.	33 32	1.81	1.207	.778	.637	.029	.100	.064	73.3	9.1	6.5	
3:34 a. m.	42 09	1.49	1.278	.822	.655	.032	.079	.056	78.1	10.1	8.0	N_{PC}, T_M aloft.
0:05 p. m.	70 50	1.06	1.195	.758	.611	.097	.180	.138	72.2	8.6	8.0	
June 20, 1936												
5:52 p. m.	21 16	2.74	.651	.460	.379	.121	.188	.154	47.4	12.7	7.4	N_{PC}, becoming T_M.
June 22, 1936												
5:06 a. m.	25 02	2.37	1.206	.814	.670	.031	.037	.034	74.6	10.4	6.6	
3:51 a. m.	38 58	1.59	1.321	.871	.707	.046	.080	.063	76.4	2.0	1.6	N_{PC}, dry N_{PP} aloft.
0:05 a. m.	71 08	1.06	1.443	.959	.743	.035	.024	.030	80.9	10.3	9.6	
June 23, 1936												
5:03 a. m.	24 45	2.38	1.074	.722	.591	.038	.095	.066	65.9	8.6	5.4	
3:35 a. m.	42 00	1.49	1.245	.789	.638	.035	.121	.078	74.4	7.7	6.1	N_{PC}, dry N_{PP} aloft.
1:58 a. m.	59 10	1.17	1.270	.808	.635	.063	.096	.080	79.4	11.8	10.1	
June 25, 1936												
2:33 a. m.	53 11	1.25	1.237	.790	.628	.071	.125	.098	75.0	9.1	8.0	N_P.
0:33 a. m.	69 58	1.06	1.316	.827	.666	.067	.125	.096	77.6	7.3	6.7	
June 28, 1936												
5:34 p. m.	20 02	2.90	.936	.637	.523	.053	.091	.072	61.2	11.4	6.7	N_P.
June 29, 1936												
3:22 a. m.	44 37	1.42	1.330	.838	.669	.019	.082	.050	79.9	9.0	7.4	N_{PC}.
2:20 p. m.	55 19	1.21	1.294	.822	.659	.066	.149	.108	74.4	5.4	4.3	
June 30, 1936												
2:34 a. m.	52 52	1.25	1.245	.785	.632	.071	.090	.080	82.0	13.7	12.1	N_{PC}, T_M aloft.
3:09 p. m.	46 36	1.38	1.287	.804	.643	.029	.101	.065	77.7	9.1	7.6	

Atmospheric conditions during solar radiation measurements. Blue Hill Observatory of Harvard University

Date and time from apparent noon	Air temperature	Wind Beaufort	Visibility (0–10)	Sky blueness	Cloudiness and remarks
June 1936	° C.				
1; 4:34 a. m.	+16.8	SSW 4	7	6	7 Acu; mod. haze.
2; 2:34 p. m.	+26.4	SSW 6	7	6	3 Ci; dense forest fire smoke.
3; 2:09 a. m.	+22.5	S 3	6	5	Zero clouds; dense water haze.
3; 2:49 p. m.	+21.1	SSE 3	7	6	Zero clouds; dense water haze.
5; 1:52 a. m.	+20.0	NE 3	8	8	2 Ci; light to moderate haze.
5; 0:22 p. m.	+21.2	ENE 3	8	8	Few Ci; 2 Cu; light haze.
6; 4:07 a. m.	+19.2	NNE 3	8	8	Few Ci; light to moderate haze.
6; 0:27 p. m.	+22.3	E 2	8	8	Few Ci; light haze.
7; 3:16 a. m.	+21.7	S 2	8	8	3 Ci; light haze.
8; 0:27 p. m.	+21.7	NE 2	7	7	3 Ci; few Acu.
9; 4:25 p. m.	+17.2	NE 3	8	7	Few Ci; few Acu; few Cu; light haze.
16; 2:29 a. m.	+17.8	NW 4	8	7	Few Acu; few Frcu; light haze.
16; 2:54 p. m.	+21.6	NW 4	9	7	Few Ci; few Acu; few Cu; light haze.
17; 4:26 a. m.	+15.6	NNW 2	9	8	Few Ci; light haze; incinerator smoke.
17; 2:53 a. m.	+18.3	W 2	9	8	Few Ci; Few Acu; light haze.
22; 4:16 a. m.	+13.3	NW 3	9	8	1 Ci.
22; 0:02 a. m.	+17.2	NW 3	10	8	Few Ci; 1 Cu.
23; 3:55 a. m.	+17.8	E 2	7	8	Few Ci; light haze.
25; 2:49 a. m.	+18.1	NW 2	8	8	2 Ci; few acu; few Cu; light haze.
29; 3:45 a. m.	+15.1	WNW 4	9	8	Few Ci; 1 Cu and Frcu; wind gusty.
29; 3:19 a. m.	+15.7	WNW 4	9	8	Few Ci; wind gusty.
30; 2:21 a. m.	+15.6	SW 2	9	6	4 Acu; few Cu; light haze.
30; 1:30 p. m.	+20.2	W 4	9	7	Few Ci; 2 Cu; light haze.

POSITIONS AND AREAS OF SUN SPOTS

Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1936	h m	°	°	°				
June 1	11 55	−33.0	135.7	−25.0		123		U. S. Naval.
		−25.0	143.7	−18.0		617		
		+34.0	202.7	−16.0		278		
		+64.0	232.7	+23.0		154	1,172	
June 2	12 15	−19.0	136.3	−24.5		123		Do.
		−11.0	144.3	−18.0		463		
		+17.0	172.3	+31.5		62		
		+47.0	202.3	−16.0		278		
		+72.0	227.3	+23.5		31	957	
June 3	12 48	−6.0	135.7	−24.0		278		Do.
		+3.0	144.7	−18.0		370		
		+30.0	171.7	+31.0		46		
		+62.6	203.7	−16.0		247	941	
June 4	9 0	−3.0	127.6	+20.0		8		Mt. Wilson.
		+6.0	136.6	−24.0		464		
		+15.0	145.6	−18.0		109		
		+16.0	146.6	+19.0	2			
		+73.0	203.6	−16.0		39	622	
June 5	12 13	−45.0	70.6	−29.5		93		U. S. Naval.
		+11.0	126.6	+20.0		154		
		+18.0	133.6	−25.0		185		
		+25.0	140.6	−25.0	216			
		+28.0	143.6	−19.0		64		
		+33.0	148.6	−15.0		123	835	
June 6	11 39	−57.0	45.7	−25.5		93		Do.
		−31.5	71.2	−29.5		123		
		+24.0	126.7	+20.0		154		
		+32.0	134.7	−25.0		123		
		+38.0	140.7	−25.0	185		678	
June 7	13 19	−44.0	44.5	−26.0		154		Do.
		+37.0	125.5	+20.0		154		
		+47.0	135.5	−25.0		123		
		+52.0	140.5	−25.0	185		616	
June 8	13 0	−69.0	6.4	−26.0	87			Mt. Wilson.
		−30.0	45.4	−24.0		232		
		−2.5	72.9	+17.0		2		
		−1.0	74.4	−28.0	37			
		+50.0	125.4	+20.0		151		
		+65.0	140.4	−23.0		859		
		+75.0	150.4	−15.0	8		1,376	
June 9	14 49	−56.0	5.2	−27.0	62			U. S. Naval.
		−19.0	42.2	−25.0	31			
		−11.0	50.2	−25.5	93			
		+11.0	72.2	−29.0		31		
		+61.0	122.2	+20.5	46			
		+78.0	139.2	−24.0		309	572	
June 10	12 7	−45.0	4.5	−27.5	62			Do.
		−8.0	41.5	−25.0	15			
		−0.5	49.0	−26.5	77			
		+75.0	124.5	+20.0		46	200	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
	h m	°	°	°				
June 11	11 49	−39.0	357.4	+22.0	31			U. S. Naval.
		−31.0	5.4	−28.0	93			
		−31.0	5.4	−16.0		46		
		−14.0	22.4	−21.0	31			
		+12.0	48.4	−26.5		77	278	
June 12	13 45	−78.0	304.1	+17.0		8		Mt. Wilson.
		−36.0	346.1	+23.0		25		
		−19.0	3.1	−27.0	35			
		+14.0	36.1	+14.0	11			
		+25.0	47.1	−25.0	58		137	
June 13	11 43	−23.0	347.0	+22.5		93		U. S. Naval.
		−8.0	2.0	−27.0		23		
		+24.0	34.0	−18.0	15			
		+38.0	48.0	−26.0	46		177	
June 14	13 10	−9.0	346.9	+22.0		35		Mt. Wilson.
		−5.0	350.9	+11.0	2			
		+6.0	1.9	−28.0		8		
		+51.0	46.9	−25.0	52		97	
June 15	12 13	−85.0	258.2	+19.0		216		U. S. Naval.
		−80.0	263.2	+23.0		62		
		+1.0	344.2	+23.0		77		
		+65.0	48.2	+26.0		46	401	
June 16	12 24	−71.0	258.9	+18.5		556		Do.
		−67.0	262.9	+27.0		154		
		+23.0	352.9	+15.0		93	803	
June 17	12 18	−80.0	236.7	+22.0		46		Do.
		−68.0	248.7	+12.0	23			
		−58.0	258.7	+18.5		741		
		−53.0	263.7	+27.0		77		
		+24.0	340.7	+22.0		93	980	
June 18	15 39	−65.0	236.6	+22.0	62			Do.
		−42.0	259.6	+18.5		617		
		−37.0	264.6	+27.0		62	741	
June 19	12 41	−70.0	220.0	+25.0		46		Do.
		−52.0	238.0	+21.0	31			
		−30.0	260.0	+19.0		525		
		−28.0	262.0	+26.0		62		
		+15.5	305.5	+18.0		77		
		+16.5	306.5	+10.5		123		
		+56.0	346.0	+18.0		31		
		+59.0	349.0	+25.0		31	926	
June 20	11 48	−59.0	218.3	+25.0		77		Do.
		−40.0	237.3	+20.5	31			
		−20.0	257.3	+19.0		494		
		−10.0	267.3	+18.0	62			
		−14.0	263.3	+27.0		93		
		+28.0	305.3	+18.0		46		
		+29.5	306.8	+11.0		31	834	
June 21	11 7	−46.0	218.4	+25.5		62		Do.
		−28.0	236.4	+21.0	31			
		−7.0	257.4	+19.0		401		
		−2.0	262.4	+27.0		62		
		+2.0	266.4	+18.0	46			
		+41.0	305.4	+18.0		46		
		+43.0	307.4	+11.0		31	679	
June 22	12 23	−68.0	182.5	−19.5		154		Do.
		−34.0	216.5	+26.0		31		
		−15.0	235.5	+21.0	23			
		+5.0	255.5	+20.0		309		
		+18.0	268.5	+18.0	46			
		+55.0	305.5	+11.0		31	594	
June 23	13 15	−51.0	185.8	−19.0		340		Mt. Wilson.
		−17.0	219.8	+27.0		8		
		0.0	236.8	+22.0	4			
		+6.0	242.8	+14.0		11		
		+24.0	260.8	+20.0		412		
		+25.5	262.3	+27.0		52		
		+48.0	284.8	−28.0		202		
		+66.0	302.8	−14.0	2			
		+79.0	315.8	+10.0	5		1,036	
June 24	12 50	−39.0	184.8	−19.0		308		Do.
		+1.0	224.8	+26.0	3			
		+23.0	246.8	+14.0		4		
		+23.0	246.8	+28.0	2			
		+39.0	262.8	+20.0		438		
		+43.0	266.8	+27.0	2			
		+59.0	282.8	−28.0		261	1,018	
June 25	11 40	−32.0	179.2	−20.0	15			U. S. Naval.
		−24.5	186.7	−19.5		185		
		−11.0	200.2	+19.0		123		
		+32.0	243.2	+11.0		46		
		+43.0	254.2	+19.0		401		
		+50.0	261.2	+17.0		123		
		+70.0	281.2	−27.5		247	1140	
June 26	12 16	−43.0	154.6	−20.0	15			Do.
		−11.0	186.6	−20.0	123			
		+3.0	200.6	+18.0		463		
		+48.0	245.6	+11.0		46		
		+63.9	260.6	+27.0	15			
		+64.0	261.6	+19.0		370	1032	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
	h m	°	°	°				
June 27	8 50	−42.0	144.3	+16.0	4			Mt. Wilson.
		−30.5	155.8	−19.0		16		
		+1.0	187.3	−19.0		150		
		+15.0	201.3	+17.0		439		
		+40.0	226.3	+24.0	10			
		+62.5	248.8	+14.0		3		
		+75.0	261.3	+23.0		151		
		+76.0	262.3	+28.0	3			
		+80.0	266.3	−14.0	22		798	
June 28	11 15	−22.0	149.7	−18.5		46		U. S. Naval.
		−15.0	156.7	−19.5	15			
		+10.0	181.7	−20.0		46		
		+16.0	187.7	−19.0	77			
		+30.0	201.7	+19.0		494	678	
June 29	11 36	−8.0	150.3	−19.0		62		Do.
		+25.0	183.3	−20.0		309		
		+43.0	201.3	+27.0		46		
		+44.0	202.3	+19.0		494	911	
June 30	12 21	+4.0	149.0	−19.0		31		Do.
		+38.0	183.0	−20.0		278		
		+57.0	202.0	+19.0		617		
		+57.0	202.0	+27.0		77	1003	

Mean daily area for 30 days, 741.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, JUNE 1936

[Data dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

June 1936	Relative numbers	June 1936	Relative numbers	June 1936	Relative numbers
1	78	11	35	21	*bd*119
2	98	12	*Ec*40	22	*b*100
3	*b*65	13	43	23	*Wc*76
4	*Mac*—	14	32	24	71
5	62	15	*d*19	25	*Mc*89
6		16	55	26	*a*112
7	*Ec*69	17	67	27	*a*103
8	73	18	60	28	68
9	64	19	101	29	68
10	*a*40	20	88	30	79

Mean, 28 days = 70.5.

a = Passage of an average-sized group through the central meridian.
b = Passage of a large group or spot through the central meridian.
c = New formation of a center of activity: *E*, on the eastern part of the sun's disk; *W*, on the western part; *M*, in the central circle zone.
d = Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in Charge]

By L. P. HARRISON

The normal monthly means of temperature and humidity used as a basis for computing the departures from normal given in table 1 are derived from observations distributed over the following numbers of years: Omaha, 5; Pensacola, 9; Seattle, 6; San Diego, 8; Washington, 11; Norfolk, 8; and Pearl Harbor, 7. The total number of observations represented by the normal in each case is indicated in the note at the foot of the table.

The departures from normal temperature during June in the middle Atlantic coastal area were of negative sign at all levels as evidenced by data for Norfolk and Washington. The departures for Norfolk appear especially significant since they amounted to as much as −2.5° C. at 5 km and at the surface. A scrutiny of the isothermal charts for the month at the various levels disclosed a rather pronounced trend of the isotherms in the general direction WNW to ESE as the coast is approached in the levels from 2–4 km over the northeastern corner of the country. From this and the facts previously adduced, one is led to infer that temperatures were generally below normal in this sector during June, at least at moderate elevations (2.5 km). Furthermore, temperatures for the month in the Lake region appeared below normal in the lower elevations.

The departures from normal of the temperatures at Omaha were mostly positive but small in magnitude; the largest was +1.0° C. at 4 km. The departures at San Diego were all positive except at the surface (−0.7° C.), most of them being small to moderate in magnitude; the largest was +2.0° C. at 5 km. Similarly, the departures at Pensacola were all positive except at the surface (−1.4° C.), most of them being quite small in magnitude, and the largest +0.9° C. at 1 km. Seattle had too few observations (7) to give reliable results in this connection.

The departures from normal relative humidity during June were mostly positive at Norfolk but negative at Washington; the largest was +7 percent at 2 and 2.5 km in the former case, and +12 percent at the surface with −7 percent at 0.5 km in the latter case. At the 4- and 5-km levels, both stations were in agreement by having positive departures of small magnitude (1–4 percent). Isohygrometric lines on the charts for the various levels reveal an outstanding maximum at Mitchel Field, especially at 4 km, and a very rapid decrease in relative humidity southward therefrom; thus at this level monthly means were: Mitchel Field, 73 percent; Lakehurst, 44 percent; Washington, 52 percent; and Norfolk, 49 percent. Boston had a corresponding mean of 57 percent, but this is probably in error by being somewhat too low, inasmuch as this station had but 19 observations during June, whereas Mitchel Field had 25, and a number of the days for which data are lacking at the former place were predominantly days with fog, low ceiling, and rain. We are thus led to infer that probably the free-air relative humidities were generally above normal in a strip along the coast in the northeastern sector of the country. This inference is consistent with the above-normal precipitation during June in this region.

The humidities at Pensacola were mostly below normal but the departures were small in magnitude, with the largest negative departure, −3 percent, at 5 km; however at the surface there was a positive departure of +8 percent.

Omaha had fairly large negative departures in the lowest levels (surface to 1.5 km, m. s. l.); the largest was −10 percent at 0.5 km above sea level (0.2 km above surface). However, small positive departures (1–3 percent) occurred at the 2.5-, 3-, and 5-km levels.

Comparing, on the isohygrometric charts, the data for the two stations last referred to with the data for other stations in the Mississippi-Missouri watershed, there appear to be three outstanding loci or centers with pronounced deficiency of humidity: (*a*) the upper Mississippi-Missouri watershed in the lower levels (surface to about 2 km above sea level), (*b*) the lower Mississippi watershed at moderate and high elevations (2.5–5 km), and (*c*) the Great Lakes region at high elevations (4–5 km). The loci of these three regions are best exemplified

by the following stations, as scrutiny of their data will show: (*a*) Omaha, Scott Field (near St. Louis), Fargo, and Billings; (*b*) Barksdale Field (Shreveport), Kelly Field (San Antonio), Pensacola, Maxwell Field (Montgomery), Murfreesboro, and Scott Field; and (*c*) Selfridge Field (near Detroit).

In the west coast region, departures from normal humidity over San Diego were mostly positive, and in lowest and highest levels quite considerable in magnitude; the largest were +10 percent at surface, and +15 percent at 5 km. The data for Seattle are unreliable owing to fewness of observations (7); however, it appears probable that the departures for the month at that place were actually positive on the whole as indicated in the table.

The upper-air wind *resultants* (see table 2) for June did not depart very greatly from normal either in direction or velocity over the northeast coastal region. It is perhaps significant that the departures in velocity were slightly negative at Boston from the surface to 1 km, but positive from 1.5 to 3 km; the largest was 1.9 m. p. s. at 2.5 km.

At Key West, the resultant at 3 km was rotated about 60° clockwise with respect to the normal in direction, and was 0.9 m. p. s. greater in velocity; at 4 km the directions of the resultant and the normal were practically coincident, but the former was 3.0 m. p. s. greater in magnitude, thus indicating a greater transport of air at these levels from the Gulf of Mexico to the Atlantic. In the lower levels, however (0.5–2.5 km), the monthly resultants were slightly weaker than normal but nearly the same in direction.

An outstanding feature of the June charts of free-air resultant winds was the appearance of an anticyclonic circulation in the States immediately north of the Gulf in the layer from about 1.5 to 3 km. It is very significant for an understanding of the month's weather that, in general, the resultant velocities were below normal on the western side of this circulation, thus reducing the northward transport of warm, moist air up the Mississippi Valley in the lower elevations, whereas they were above normal on the eastern side of the circulation and moreover were rotated clockwise with respect to the normal direction by from 120° to 180° in the layer 1.5–3 km. This signifies that the transport of warm, moist air into the east Gulf States from the Gulf was somewhat deficient. Also relevant in this connection were the excessive values at high levels for St. Louis: 4 km resultant 311°, 7.9 m. p. s., normal 290°, 4.9 m. p. s.; 5 km resultant 312°, 10.8 m. p. s., normal 294°, 5.5 m. p. s. Similarly for Atlanta: 5 km resultant, 330°, 6.2 m. p. s.; normal, 308°, 3.1 m. p. s.

The facts thus adduced are indicative of stagnant conditions in the lower Mississippi and Great Plains region with consequent abnormal warming of the air and lowering of relative humidity, consistent with the data previously discussed.

At the 3-km level the resultant winds over the central part of the country did not, in general, depart much from normal. At the 5-km level, however, in contrast to the positive departures from normal at St. Louis and Atlanta already cited, there were negative departures in velocity of 3.5 and 3.0 m. p. s. at Cheyenne and Albuquerque, respectively, the directions being essentially normal.

The resultants for Salt Lake City were slightly greater in magnitude than the normals with one exception, and in the levels from 2–5 km above sea were oriented about 30°–40° southward from the normal.

Along the west coast the resultant winds exhibited some striking departures from normal. At San Diego the resultant for the month at the surface was oriented about 60° north of the normal and was 0.7 m. p. s. greater in magnitude. The remaining levels for which data were available showed slightly positive departures in velocity but insignificant or small departures in direction. Considering the resultants for Medford, Seattle, and Spokane as a whole, large positive departures in velocity (>3 m. p. s.) and in direction with respect to the normals were the rule at moderate and high elevations (2–5 km). The Oakland resultants did not depart greatly from normal insofar as magnitude was concerned but the departures in direction were large. In general, the directions of the monthly resultants at the four stations last referred to were oriented on the average about 50° counterclockwise (south) of normal. The significance of the facts just presented lies in the larger than normal transport of warm, moist air from the Pacific over the coastal area and adjoining mountain regions with the consequent occurrence during June of an excessively large amount of precipitation throughout the Pacific States (232 percent of normal in California, 161 percent in Oregon, 211 percent in Washington, 172 percent in Idaho, 160 percent in Nevada, and 120 percent in Utah).

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during June 1936*

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.																Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La.[1] (52 m)	23.0	-------	25.0	-------	22.5	-------	19.7	-------	17.0	-------	14.7	-------	11.6	-------	4.9	-------	−2.9	-------	30
Billings, Mont.[2] (1,088 m)	16.4	-------	-------	-------	17.4	-------	14.5	-------	10.8	-------	6.9	-------	−0.5	-------	−8.3	-------	29
Boston, Mass.[1] (5 m)	16.1	-------	16.6	-------	13.7	-------	10.7	-------	8.1	-------	5.8	-------	3.2	-------	−2.6	-------	−7.8	-------	19
Cheyenne, Wyo.[2] (1,873 m)	13.8	-------	-------	-------	-------	-------	-------	-------	15.5	-------	14.7	-------	11.8	-------	4.1	-------	−4.3	-------	30
El Paso, Tex.[2] (1,194 m)	23.0	-------	-------	-------	-------	-------	24.5	-------	22.5	-------	18.3	-------	14.2	-------	6.5	-------	−1.6	-------	30
Fargo, N. Dak.[2] (274 m)	14.8	-------	17.2	-------	15.2	-------	13.0	-------	11.0	-------	7.9	-------	4.9	-------	−1.2	-------	−7.8	-------	30
Kelly Field (San Antonio), Tex.[1] (206 m)	22.4	-------	24.1	-------	22.7	-------	19.8	-------	18.0	-------	16.1	-------	13.4	-------	6.4	-------	−0.7	-------	27
Lakehurst, N. J.[3] (39 m)	18.4	-------	18.7	-------	17.4	-------	14.6	-------	12.3	-------	10.3	-------	7.7	-------	2.2	-------	−3.2	-------	22
Maxwell Field (Montgomery), Ala.[1] (52 m)	22.7	-------	24.9	-------	22.7	-------	19.0	-------	15.3	-------	12.0	-------	9.5	-------	3.8	-------	−2.4	-------	30
Mitchel Field (Hempstead, Long Island), N. Y.[1] (29 m)	16.4	-------	17.9	-------	16.0	-------	13.2	-------	10.8	-------	8.6	-------	6.0	-------	−0.4	-------	-------	-------	25
Murfreesboro, Tenn.[2] (174 m)	20.7	-------	24.2	-------	22.4	-------	19.1	-------	15.9	-------	13.1	-------	10.4	-------	4.1	-------	−2.2	-------	30
Norfolk, Va.[3] (10 m)	20.0	−2.5	20.8	−0.7	18.1	−1.2	14.6	−1.7	11.2	−2.0	8.3	−2.1	6.3	−1.5	0.5	−1.9	−5.2	−2.5	20
Oklahoma City, Okla.[2] (391 m)	21.4	-------	23.0	-------	23.1	-------	20.7	-------	18.1	-------	15.2	-------	11.5	-------	3.8	-------	-------	-------	30
Omaha, Nebr.[2] (300 m)	18.6	−0.1	20.2	+0.1	19.9	−0.7	18.3	+0.1	15.5	+0.2	12.1	+0.3	9.1	+0.8	2.6	+1.0	−4.8	+0.4	30
Pearl Harbor, Territory of Hawaii[3] (6 m)	22.8	−2.3	20.8	−1.1	17.5	−0.8	15.2	−0.5	13.7	+0.2	11.6	−0.3	9.5	−0.7	5.0	−1.2	−0.4	−1.5	30
Pensacola, Fla.[3] (13 m)	23.2	−1.4	24.1	+0.8	21.4	+0.9	18.0	+0.4	15.1	+0.4	12.3	+0.4	9.6	+0.6	3.7	+0.5	−2.1	+0.5	30
San Diego, Calif.[3] (10 m)	18.1	−0.8	16.2	+0.3	19.5	+1.9	19.6	+1.4	17.5	+0.1	15.7	+0.8	13.2	+1.2	7.2	+1.4	0.9	+2.0	28
Scott Field (Belleville), Ill.[1] (135 m)	17.4	-------	21.6	-------	20.9	-------	18.1	-------	15.4	-------	12.3	-------	9.3	-------	2.8	-------	−3.9	-------	30
Seattle, Wash.[3] (10 m)	17.0	+1.6	12.0	−0.2	9.4	−0.3	6.9	−0.3	4.8	0.0	2.1	−0.4	−0.1	−0.3	−6.7	−1.9	-------	-------	7
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	13.9	-------	16.5	-------	15.4	-------	12.8	-------	10.3	-------	7.9	-------	5.0	-------	−1.3	-------	−7.7	-------	29
Spokane, Wash.[3] (596 m)	13.6	-------	-------	-------	16.7	-------	16.1	-------	13.4	-------	10.0	-------	6.8	-------	0.2	-------	−6.6	-------	30
Sunnyvale, Calif.[3] (10 m)	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Washington, D. C.[3] (13 m)	18.2	−3.2	19.2	−0.9	17.2	−0.8	14.3	−1.0	11.4	−1.0	8.9	−0.4	6.4	−0.5	0.6	−0.5	−5.0	−0.3	29
Wright Field (Dayton), Ohio[1] (244 m)	16.0	-------	19.4	-------	19.2	-------	16.5	-------	13.9	-------	11.2	-------	8.3	-------	2.0	-------	−4.3	-------	22

RELATIVE HUMIDITY (PERCENT)

Barksdale Field (Shreveport), La.	75	-------	59	-------	54	-------	52	-------	46	-------	36	-------	33	-------	31	-------	30	-------	-------
Billings, Mont.	56	-------	-------	-------	-------	-------	46	-------	46	-------	52	-------	58	-------	60	-------	52	-------	-------
Boston, Mass.	75	-------	62	-------	64	-------	64	-------	62	-------	60	-------	57	-------	57	-------	56	-------	-------
Cheyenne, Wyo.	66	-------	-------	-------	-------	-------	-------	-------	58	-------	49	-------	46	-------	50	-------	57	-------	-------
El Paso, Tex.	34	-------	-------	-------	-------	-------	41	-------	42	-------	44	-------	46	-------	50	-------	55	-------	-------
Fargo, N. Dak.	71	-------	57	-------	54	-------	52	-------	48	-------	51	-------	52	-------	49	-------	50	-------	-------
Kelly Field (San Antonio), Tex.	88	-------	81	-------	71	-------	72	-------	59	-------	48	-------	40	-------	37	-------	36	-------	-------
Lakehurst, N. J.	77	-------	66	-------	56	-------	55	-------	55	-------	51	-------	50	-------	44	-------	41	-------	-------
Maxwell Field (Montgomery), Ala.	82	-------	61	-------	58	-------	61	-------	60	-------	58	-------	49	-------	40	-------	35	-------	-------
Mitchel Field (Hempstead, Long Island), N. Y.	87	-------	78	-------	77	-------	87	-------	73	-------	67	-------	66	-------	73	-------	-------	-------	-------
Murfreesboro, Tenn.	63	-------	54	-------	55	-------	57	-------	59	-------	56	-------	50	-------	46	-------	40	-------	-------
Norfolk, Va.	83	+6	64	−4	62	−2	67	+4	60	+7	66	+7	55	+1	49	+2	43	+4	-------
Oklahoma City, Okla.	70	-------	64	-------	55	-------	53	-------	48	-------	43	-------	42	-------	42	-------	-------	-------	-------
Omaha, Nebr.	73	−7	59	−10	50	−5	47	−6	51	−1	56	+3	54	+2	45	−3	45	+1	-------
Pearl Harbor, Territory of Hawaii	82	+11	83	+7	85	+4	76	−1	56	−12	45	−8	38	−2	22	0	32	+15	-------
Pensacola, Fla.	90	+8	72	−2	68	−1	67	0	63	−1	58	−2	53	−2	49	−1	41	−3	-------
San Diego, Calif.	84	+10	84	+4	53	−4	37	−2	34	+7	27	+5	27	+8	30	+12	33	+15	-------
Scott Field (Belleville), Ill.	72	-------	53	-------	51	-------	52	-------	48	-------	49	-------	47	-------	42	-------	35	-------	-------
Seattle, Wash.	72	0	76	+2	73	0	72	+1	62	−6	65	+1	64	+5	66	+14	-------	-------	-------
Selfridge Field (Mount Clemens), Mich.	82	-------	63	-------	56	-------	56	-------	53	-------	47	-------	46	-------	42	-------	36	-------	-------
Spokane, Wash.	79	-------	-------	-------	66	-------	64	-------	67	-------	70	-------	71	-------	72	-------	65	-------	-------
Washington, D. C.	84	+12	57	−7	55	−6	57	−5	57	−6	54	−6	52	−4	52	+1	46	+3	-------
Wright Field (Dayton), Ohio	77	-------	65	-------	59	-------	59	-------	57	-------	53	-------	53	-------	55	-------	55	-------	-------

[1] Army. [2] Weather Bureau. [3] Navy.

Observations taken about 4:00 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on "normals" covering the following total number of observations made during the same month in previous years, including the current month: Norfolk, 161; Omaha, 150; Pearl Harbor, 140; Pensacola, 217; San Diego, 172; Seattle, 68; Washington, 231.

LATE REPORT FOR MAY 1936

TEMPERATURE (° C.)

Pearl Harbor, Territory of Hawaii[3] (6 m.)	21.6	−3.2	19.2	−2.0	15.4	−1.9	12.3	−2.2	11.5	−1.1	11.7	−0.2	9.3	−0.9	2.9	−2.1	−5.3	−4.6	31

RELATIVE HUMIDITY (PERCENT)

Pearl Harbor, Territory of Hawaii.	78	+9	80	+6	85	+5	82	+6	61	−3	33	−10	25	−6	19	−2	18	−1	-------

NOTE.—The departures are based on "normals" covering the following total number of observations made during the same month in previous years, including the current month: Pearl Harbor, 139.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 6 a. m. (E. S. T.) during June 1936*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	321	1.2	214	0.6	346	1.7	283	1.3	270	2.4	24	1.0	11	0.6	299	1.6	144	1.3	95	0.3	149	2.6	291	0.8	273	0.8
500	------	------	226	2.1	------	------	280	4.9	------	------	100	2.2	131	.5	299	2.7	185	1.6	150	4.6	155	4.0	279	1.5	224	1.3
1,000	------	------	264	3.1	------	------	276	5.1	------	------	278	.8	281	2.3	301	4.1	278	3.0	149	4.7	162	2.3	293	1.8	271	2.3
1,500	------	------	296	2.3	33	1.4	281	6.3	------	------	277	4.8	287	4.6	290	5.5	257	4.8	133	4.0	150	2.0	196	.6	287	2.5
2,000	217	2.2	295	2.7	301	.4	277	8.7	261	3.8	276	6.8	280	5.6	294	6.4	286	7.4	108	3.2	144	.6	187	2.1	306	4.0
2,500	238	3.7	325	1.8	259	3.5	269	10.5	253	6.0	285	7.5	287	6.1	304	6.2	304	9.7	82	4.1	207	1.8	206	7.2	300	4.9
3,000	245	3.8	332	2.5	264	5.6	278	11.2	255	6.2	294	8.2	292	6.4	289	5.3	301	10.0	75	4.1	218	3.1	204	9.8	316	4.6
4,000	243	4.4	345	4.1	249	9.1	------	------	260	6.4	302	9.2	314	6.6	313	7.0	298	10.0	58	4.5	222	4.8	216	11.3	345	4.8
5,000	249	1.7	330	6.2	254	9.5	------	------	273	5.2	317	10.8	344	7.9	308	7.8	------	------	48	3.5	------	------	230	13.8	------	------

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii [1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	360	0.6	225	0.6	158	2.1	128	0.7	------	------	2	0.8	180	0.4	149	2.8	325	1.2	117	0.2	146	0.8	180	1.1	282	0.1
500	280	4.9	272	3.1	180	4.3	151	3.1	------	------	275	1.3	174	1.8	------	------	302	2.5	281	1.7	210	1.4	------	------	267	2.5
1,000	293	5.9	286	4.1	204	9.1	197	3.8	------	------	244	1.4	271	2.7	------	------	311	3.6	273	5.8	191	3.0	208	2.6	286	4.8
1,500	293	6.8	238	2.2	216	6.4	245	4.3	------	------	60	.5	281	4.9	160	3.5	289	3.4	288	7.5	205	3.6	230	3.3	290	4.9
2,000	286	7.1	213	3.4	216	4.3	272	5.8	------	------	84	1.7	283	6.9	183	3.7	------	------	288	7.3	199	4.7	231	4.6	292	6.6
2,500	280	7.5	219	4.3	225	3.1	281	6.7	------	------	49	2.1	292	5.8	205	3.9	------	------	296	8.0	197	5.8	225	5.1	276	6.7
3,000	286	8.8	212	5.1	235	1.8	284	6.6	------	------	45	2.1	309	5.0	217	5.6	------	------	289	9.5	206	7.4	237	6.6	275	7.4
4,000	279	9.2	------	------	34	1.4	290	9.2	------	------	24	3.5	311	7.9	224	7.1	------	------	296	12.2	224	8.8	236	10.1	290	5.9
5,000	------	------	------	------	41	1.3	300	11.3	------	------	------	------	312	10.8	225	7.8	------	------	302	10.0	------	------	243	12.7	------	------

[1] Navy stations.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES in Charge]

By W. J. MOXOM

The severe flood in the Arkansas River in Colorado, during the last few days of May, passed into Kansas on June 1 and gave bankfull and near bankfull stages from the Colorado line almost to Wichita, Kans. Flood stage was slightly exceeded at Great Bend, Kans. It is estimated that losses to tangible property in Kansas amounted to about $8,000. Approximately 1,800 acres of prospective crops were damaged to the extent of about $4,500 in the reach of the river embracing Dodge City, Great Bend, and Bentley, Kans.

Moderate floods occurred in the North Canadian River from Woodward to Oklahoma City, Okla.; the South Canadian River in the vicinity of Union, Okla.; and the Cimarron River near Perkins, Okla. Losses were estimated to be in excess of $100,000. Owing to the efficient work of the river observer at Perkins, Okla., the losses in that section were much smaller than otherwise would have occurred; they amounted to approximately $3,500. All families along the river in that section were called by telephone, and all movable property, such as shocked wheat, cattle, etc., was removed to higher ground.

Moderate to heavy flooding occurred during the latter part of May and the first few days of June in the Colorado and Guadalupe Rivers in Texas with estimated losses in excess of $500,000.

Minor floods occurred in some of the tributaries of the Colorado River in Colorado during the first few days of June, with little or no damage.

Unusually low river stages prevailed in the Mississippi River and some of its tributaries.

The district center at Portland, Oreg., furnishes the following remarks on the annual rise of the Columbia River:

Precipitation from September 1, 1935, to February 29, 1936, was about normal or slightly above in the Okanagan drainage, slightly below normal in the Kettle River, West Kootenai, and Arrow Lakes drainage and at Revelstoke, and as much as 30 percent below in the Columbia Basin above Golden, British Columbia, and the East Kootenai Basin. According to the Canadian Water Resources Branch at Vancouver, precipitation ranged from 60 percent to 70 percent of the normal for the Columbia drainage in Canada, although at Trail, British Columbia, the amount exceeded the 20-year average.

In southern Idaho the amount of precipitation ranged from 100 percent to 150 percent of normal, in some areas exceeding this average. The amount of water contributed by this section was proportionate. Except for comparatively small areas in Washington, northern Oregon, southwestern Montana, northern, southwestern, and east-central Idaho, where as low as 38 percent of normal was reported, precipitation over the Columbia drainage in the United States was between 75 percent and 100 percent. During the last week in May and the first week in June the rainfall was quite heavy in the mid-Columbia and Snake River drainage.

Snowfall in Canada was about two-thirds of the average, but was solidly packed, the departure being less at the higher elevations. This conclusion is the result of reports from several sources. Two points where snow survey measurements were made substantiate this view. One point, 30 miles northwest of the north end of Kootenay Lake, at an elevation of 6,000 feet, reported 86 percent of the 1935 water content. The other point, which was Sinclair, on the Banff-Windemere highway, at an elevation of

4,500 feet, reported 78 percent of the water content for the same period. The amount of snow in that portion of the Cascades drained by the Columbia River exceeded by several inches the amount recorded last year. Snow depths in the elevated districts south of the international line ranged from normal to considerably above, according to reports, and was generally above normal in water content, except in the upper Snake, where snow depths and water content were sufficient to sustain the highest average summer flow at Weiser, Idaho, since 1928.

Due to low average temperatures over the entire upper Columbia drainage during the winter and early spring, the average stage of the Columbia and its tributaries was considerably lower than normal. In January to April, inclusive, it was the lowest since 1931, when, on account of a considerable deficiency in precipitation during 1930, the river stages were abnormally low. The Dalles, Oreg., reported a stage of −3.5 feet on February 10, 1936. This exceeds by 1 foot the previous low record.

Temperatures continued low the first part of April, with freezing nights over the entire snowfield. About the 10th mean temperatures rose sharply, except over the northern portion of the Canadian drainage, and by the middle of April a considerable amount of the lowest snow had melted and all streams were rising rapidly. A stage of 15.2 feet was reached at Lewiston, Idaho, on the Snake River, on April 25; the highest stage (on May 16) exceeded this by only 1.2 feet. Mean temperatures fell considerably the middle of May, and night temperatures were near freezing on May 15 and 16. Except for a very slight rise in the Snake River the first part of June, caused by heavy precipitation and a decreased demand for irrigation water in southern Idaho, the stage fell steadily after May 16. The effective snow cover for increased run-off had been exhausted by the warm weather the last half of April and the first half of May.

Abnormally high temperatures in the interior of western Canada caused the Columbia to continue to rise. Crest stages were reached in the upper Columbia the first week in June and, accompanied by a near stationary stage in the Snake River, they advanced as far downstream as Vancouver, Wash., and Portland, Oreg., by the 11th. However, most apprehension was over when the Snake River failed to rally with the high temperatures the last week of May. Experience has shown that it is necessary to have both the upper Columbia and Snake Rivers at high stages, with a tendency to rise or rising, to produce a serious flood in the lower river. When one is rising and the other falling the effect is compensating. The hydrograph below the confluence of the two rivers is considerably flattened, and very much reduced crest stages result.

The damage resulting from the high water this season is thought to have been almost negligible. Ample warnings were issued. Tentative forecasts of 20 feet for Portland and 35 feet for The Dalles were made at the end of March. Shipping interests were advised promptly, so that the lower docks could be evacuated without damage to cargo. It was necessary for some farmers on the lowlands to delay planting and for others to purchase a small additional amount of feed; however, this is expected almost annually.

Table of flood stages during June 1936

[All dates in June, unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
Cape Fear: Lock No. 2, Elizabethtown, N. C.	20	26	26	20.0	26.
MISSISSIPPI SYSTEM					
Arkansas Basin					
Cimarron: Perkins, Okla.	11	6	7	12.8	6.
North Canadian:					
Woodward, Okla.	5	2	2	6.0	2.
		5	8	8.0	6.
Canton, Okla.	6	6	9	8.5	7.
Yukon, Okla.	8	May 27	18	11.4	11.
East Oklahoma City, Okla.	14	10	12	15.3	12.
Canadian: Union, Okla.	6			9.0	5.
Arkansas: Great Bend, Kans.	5	3	4	5.8	3.
WEST GULF OF MEXICO DRAINAGE					
Guadalupe: Victoria, Tex.	21	May 23	2	29.6	May 25.
Rio Grande: Eagle Pass, Tex.	16	29	29	20.2	29.
GULF OF CALIFORNIA DRAINAGE					
Colorado Basin					
Eagle: Eagle, Colo.	5	May 30	1	5.3	May 31.
Roaring Fork: Carbondale, Colo.	5	May 15	2	6.2	May 30, June1
		9	14	5.4	12.
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Willamette: Portland, Oreg.	18	5	14	19.7	10, 11.
Columbia: Vancouver, Wash.	15	May 6	21	20.4	10, 11.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL in Charge]

NORTH ATLANTIC OCEAN, JUNE 1936

By H. C. HUNTER

Atmospheric pressure.—Near the British Isles and the western coasts of Europe and northern Africa the pressure averaged greater than normal. However, most of the Atlantic area had pressure less than normal, particularly the vicinity of Bermuda and the regions to southwestward toward the Greater Antilles, where readings were seldom as high as normal until after the 21st.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, June 1936*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.79	−0.07	30.18	25	29.44	14
Reykjavik, Iceland	29.86	−.02	30.32	1	29.20	11
Lerwick, Shetland Islands	30.00	+.20	30.35	19	29.55	6
Valencia, Ireland	30.01	+.01	30.25	5	29.61	30
Lisbon, Portugal	30.12	+.09	30.50	5	29.75	20
Madeira	30.12	+.05	30.27	4	29.96	1
Horta, Azores	30.24	.00	30.51	6, 7, 8, 9	29.82	26
Belle Isle, Newfoundland	29.87	+.01	30.36	19	29.08	17
Halifax, Nova Scotia	29.92	−.05	30.34	24	29.28	2
Nantucket	29.91	−.07	30.29	23	29.44	28
Hatteras	29.94	−.07	30.20	26	29.66	28
Bermuda	30.02	−.11	30.22	27	29.66	16
Turks Island	29.94	−.09	30.08	26	29.79	16
Key West	29.90	−.09	30.09	30	29.58	15
New Orleans	29.92	−.06	30.12	26	29.72	1

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

The extremes of pressure so far reported from vessels are 30.70 and 29.13 inches, the former mark being recorded on the British steamship *Goolistan*, during the forenoon of the 8th, near latitude 43° N., longtiude 24° W., and the latter on the American steamship *Scanmail*, at 11 p.m., the 10th, at about 57° N., 22° W.

Cyclones and gales.—There were about as many reports of gales as usual in June. Whole gales (force 10) occurred several times, in various parts of the ocean, but in no case near or over tropical waters.

The storm most notable for its effects along the chief steamship lane to northern Europe was located between Bermuda and Newfoundland on the 1st, and moved eastward then toward the east-southeast to about the fortieth meridian on the 2d; thereafter it was practically stationary, and by the 5th had almost filled up.

During about a fortnight thereafter the few strong winds over Atlantic waters east of the fiftieth meridian were mostly related to the unusually high pressure prevailing in the region north of the Azores. The Belgian steamship *Kambove*, from Argentina to the English Channel, reported intensified northeast trade winds from the

6th to the 9th, when near the Cape Verde and Canary Islands. During the next few days, low pressure near Iceland, in connection with the HIGH, caused whole gales along part of the far-northern route, near latitude 55°, longitude 20°.

Elsewhere in this REVIEW appears an account of three tropical disturbances; all developed in the Gulf or western Caribbean, and only the first of them affected the main Atlantic Ocean. The first disturbance crossed southern Florida on the 15th and then traveled northeastward rapidly, passing northwest of Bermuda, and becoming, by the 16th, part of a north-south LOW system. On the 17th the LOW was well consolidated, with its center near the Strait of Belle Isle, whence it traveled northward to Greenland, the pressure at Godthaab on the 18th falling to 28.98 inches.

During the final week of June there were a few isolated cases of intense local storms. On the 24th vessels and airplanes south of the Dominican Republic reported squally conditions, but no cyclonic development was detected. The chief of the Meteorological Service at Santo Domingo reports that the squalls were accompanied by heavy sea swells that caused the death of 12 fishermen in small boats. A few lives were also lost at San Pedro de Macoris as a result of heavy seas. The British freighter *Baron Ogilvy* went aground at the mouth of the Nizao River and was a total loss.

At an early hour of the 29th the American steamer *Mariana*, when about 160 miles east of Hatteras, met a vigorous thunderstorm with westerly squalls estimated at force 10. Later that day or on the 30th, three vessels noted westerly gales over waters to northeastward of the *Mariana's* location, one of the three encountering a whole gale.

Fog.—Fog was unusually prevalent over many northern portions of the North Atlantic. In the vicinity of the British Isles and to southwestward half way to the Azores there were many days with fog, especially about the 10th and the 20th, and during the final few days of June. However, almost no fog was met in the eastern and central portions of the ocean anywhere to southward of the forty-fifth parallel, while along the chief route to the English Channel practically no fog was encountered between the twenty-fifth and fortieth meridians.

In the Grand Banks region there was about the normal amount of fog; but to southwestward, as far as C. Cod, fog was very prevalent, the two 5°-squares 40 to 45° N., 60 to 70° W., each having records of 20 days' occurrence. To the southwestward of Cape Cod there was considerable fog, but the first half of the month included practically all of it, while as usual in June there was scarcely a single report of fog near or to southward of Cape Hatteras.

Four disasters due to fog were reported as occurring during the 6th to 9th, fortunately without loss of life. One steamer grounded near Cape Race, Newfoundland, and a schooner on an island in the Gulf of St. Lawrence, each becoming a total loss. During the evening of the 9th two steamships collided off Sea Girt, N. J., one being greatly damaged but being towed to harbor. The fourth accident was a less serious collision in the lower St. Lawrence River.

OCEAN GALES AND STORMS, JUNE 1936

Vessel	Voyage		Position at time of lowest barometer		Gale began June	Time of lowest barometer June	Gale ended June	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
West Quechee, Am. S. S.	Galveston	Liverpool	42 40 N.	42 35 W.	2	4p, 2	2	29.61	ENE.	NE, 10	NE.	NE, 10	E-NE.
Cavina, Br. S. S.	Kingston	Avonmouth	42 42 N.	42 59 W.	2	8p, 2	2	29.58	NE.	NNE, 8	NE.	NNE, 8	NE-NNE-NE.
Lekhaven, Du. S. S.	Galveston	Bremen	41 30 N.	44 40 W.	2	2a, 3	3	29.75	NNE.	NNW, 8	NE.	NNW, 9	Steady.
Lustrous, Br. S. S.	Port Arthur	Amsterdam	41 00 N.	42 10 W.	2	8p, 3	3	29.61	NNW.	N, 6	NE.	NNW, 8	NW-NE.
Kambove, Belg. S. S.	Buenos Aires	Antwerp	8 28 N.	28 20 W.	6		9		NE.		NE.	NE, 7	None.
Boskoop, Du. S. S.	Cristobal	Liverpool	39 35 N.	42 40 W.	4	1p, 4	4	29.69	NW.	NE, —	ENE.	N, 8	NNW-NE.
Frode, Dan. S. S.	New York	Oslo	54 22 N.	33 20 W.	9	Mdt, 9	10	29.19	SE.	W, —	NW.	WNW, 10	SW-W.
McKeesport, Am. S. S.	Dundee	Boston	56 10 N.	23 15 W.	10	4p, 10	11	29.36	SSE.	WSW, 9	W	WNW, 10	SSW-WNW.
West Cohas, Am. S. S.	Glasgow	New Orleans	54 06 N.	11 50 W.	14	8a, 14	15	29.68	WSW.	W, —	W	W, 8	SSW-W.
Mayari, Pan. S. S.	Boston	Banes, Cuba	25 46 N.	73 08 W.	15	2a, 16	16	29.57	S.	W, 8	N	W, 8	SSW-W-N.
Duquesne, Am. S. S.	Rotterdam	New Orleans	29 21 N.	70 24 W.	15	6a, 16	16	29.46	SSE.	N, 7	N	S, 8	S-Var.-N.
Sundance, Am. S. S.	Terneuzen	Newport News	[2] 38 57 N.	56 58 W.	16		18	29.75	SSE.	NNW, 7	NNE.	SSE, 9	SSE-NNW-NNE.
New York, Ger. S. S.	Cherbourg	New York	42 00 N.	54 48 W.	17	5p, 17	18	29.69	SSE.	S, 8	N	SSE, 8	S-N.
Themisto, Du. S. S.	Montreal	Antwerp	52 20 N.	51 30 W.	17	6p, 17	17	[2] 29.51	S.	S, 8	WNW.	S, 9	S-WNW.
Exchester, Am. S. S.	Lisbon	New York	40 20 N.	17 13 W.	19	8p, 19	20	29.48	SW.	W, 9	NNW.	W, 9	WSW-NW.
Cayo Mambi, Am. S. S.	Puerto Mexico	New Orleans	[2] 23 58 N.	91 34 W.	19	9p, 19	20	29.52	NNW.	Var., 2	E.	E, 8	NW-Var.-E.
Venezuela, Du. S. S.	Barbados	Plymouth	45 10 N.	19 40 W.	19	6a, 20	20	29.57	NW.	N, 6	NNE.	NNW, 8	NNW-NNE.
Exchester, Am. S. S.	Lisbon	New York	[2] 41 59 N.	38 57 W.	24	4p, 24	25	29.98	NW.	NW, 4	NNW.	NNW, 8	Steady.
Mariana, Am. S. S.	Jobos, P. R.	do	[2] 35 26 N.	72 10 W.	29		29		SW.		W	W, 10	SW-W.
Laurent Meeus, Belg. M. S.	Amsterdam	Houston	38 56 N.	57 57 W.	28	8a, 29	30	29.62	SW.	SW, 9	SW.	SW, 9	
Exchester, Am. S. S.	Lisbon	New York	41 16 N.	57 28 W.	28	10a, 29	30	29.58	WSW.	SW, 8	WNW.	SW, 10	SW-W.
New Brunswick, Br. S. S.	Dakar	Boston	37 50 N.	63 10 W.	29	Mdt. 30	30	29.73	SW.	SW, 8	Var.	SW, 8	SW-Var.
NORTH PACIFIC OCEAN													
Golden Sun, Am. S. S.	San Francisco	Yokohama	38 07 N.	178 00 E.	[1] 31	3p, [1] 31	1	29.47	S.	SW, 9	N.	NW, 10	S-WSW.
Golden Dragon, Am. S. S.	do	do	37 06 N.	154 07 E.	1	4p, 1	2	28.92	SE.	SW, 10	NW.	W, 11	S-W.
Bronxville, Nor. M. S.	Santo Nino	Los Angeles	[2] 37 08 N.	161 00 E.	1	2a, 2	3	29.27	SSE.	WSW, —	NW.	SW, 11	SW-WSW-W.
Golden Sun, Am. S. S.	San Francisco	Yokohama	37 48 N.	171 18 E.	2	11a, 2	3	29.53	SSE.	SSE, 10	WNW.	SSE, 10	SSE-SW.
Golden Hind, Am. S. S.	Dairen	San Francisco	31 35 N.	171 40 E.	2	2p, 2	2	29.61	S.	S, 8	W.	S, 8	S-W.
Nordhval, Dan. M. S.	Vancouver, B. C.	Balboa	[2] 12 39 N.	92 38 W.	9	8a, 9	9	[2] 29.18	ENE.	E, 9	SW.	SSE, 10	ENE-S.
Constance Chandler, Am. S. S.	Los Angeles	do	13 15 N.	93 55 W.	9	4p, 9	10	29.53	NW.	NW, 5	S.	SW, 10	NW-SW.
Ensley City, Am. S. S.	Balboa	Los Angeles	14 00 N.	94 30 W.	12	—, 12	12	29.67	N.	N, 7	NW.	N, 8	N-NW.
Aymeric, Br. S. S.	Los Angeles	Kobe	30 03 N.	162 32 E.	11	6a, 13	14	29.58	SSW.	NNE, 6	NE.	NE, 8	S-Var-NE.
Empress of Canada, Br. S. S.	Honolulu	Victoria, B. C.	41 20 N.	136 58 W.	16	4a, 16	16	29.65	W.	W, 7	W.	W, 8	
Steel Ranger, Am. S. S.	do	Balboa	13 58 N.	102 17 W.	22	11a, 22	23	29.49	NNW.	SW, 8	S.	SW, 8	NW-SW.
Fernlane, Nor. M. S.	Los Angeles	Yokohama	42 36 N.	175 47 E.	24	Mdt., 24	25	29.65	S.	SSW, 7	W.	W, 8	S-W.
Pres. Jackson, Am. S. S.	Seattle	do	51 44 N.	171 40 W.	25	2p, 25	26	29.53	SSW.	SW, 8	SW.	SW, 8	
Fernlane, Nor. M. S.	Los Angeles	do	39 03 N.	152 03 E.	29	9p, 29	30	29.65	S.	WSW, 9	SW.	WSW, 9	WSW-SW.

[1] May.
[2] Position approximate.
[3] Barometer uncorrected.

NORTH PACIFIC OCEAN, JUNE 1936

By WILLIS E. HURD

Atmospheric pressure.—Average barometer departures from normal were unimportant over the North Pacific Ocean for June 1936. In the Aleutian region, however, pressures were 0.05 to 0.08 above normal, while at Juneau the departure was —0.09, the values lessening southward to —0.03 at San Francisco, and to 0.00 at Mazatlan. There was little range in pressure over northern and central waters of the North Pacific, as shown by the difference between 29.95, the average at Dutch Harbor, and 30.10, the average at Midway Island, near the center of the oceanic high-pressure region. In the Tropics the lowest average pressure was 29.70 inches at Hong Kong.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, June 1936, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.97	—0.02	30.32	4	29.50	18
Dutch Harbor	29.95	+.05	30.38	22	29.50	11
St. Paul	29.94	+.08	30.30	22	29.44	11
Kodiak	29.96	+.05	30.26	21	29.54	17
Juneau	29.92	—.09	30.19	21	29.41	17
Tatoosh Island	29.98	—.04	30.25	28	29.54	7
San Francisco	29.93	—.03	30.13	8	29.69	11
Mazatlan	29.83	.00	29.92	{26, 27, 28}	29.76	17
Honolulu	30.04	.00	30.15	28	29.94	8
Midway Island	30.10	+.05	30.26	27, 28	29.96	4
Guam	29.84	—.03	29.94	1	29.76	13, 24
Manila	29.78	+.03	29.84	{1, 11, 29, 30}	29.62	7
Hong Kong	29.70	------	29.79	12, 24	29.53	3, 8
Naha	29.77	+.02	29.90	29	29.52	8
Chichishima	29.89	—.02	30.06	28	29.64	5
Nemuro [1]	------	------	------	------	------	------

[1] Data incomplete.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Although there were some movements of cyclones in the Aleutian region and over most extratropical waters east of the one-hundred and eightieth meridian this month, the weather over this great area was for the most part quiet, with few moderate gales reported by ships and only two of force 8.

The only important extratropical cyclone of the month was the continuation of a storm that appeared off the north Japanese coast on May 31. This storm was central on June 1 near 40° N., 155° E., with lowest reported pressure 28.87 inches. Two ships in the southern quadrants of the storm encountered westerly gales of force 11 on this date. On the 2d the disturbance had moved considerably to the northeastward toward the Aleutians; but was causing local gales to the southeastward, the highest of which was of force 10, near 38° N., 171° E.

Subsequently to the 2d the highest wind reported outside the Tropics was of force 9, near 39° N., 152° E., on the 29th.

Tropical disturbances.—On June 8 there were signs of development of a tropical disturbance southwest of the Gulf of Tehuantepec. The steamer *Anniston City* reported a west-northwest gale of force 7 in the afternoon, but the ship's lowest pressure was 29.70, observed at 2 a. m. of the 9th in 14°08′ N., 96°35′ W. During the 9th the Danish motorship *Nordhval* and the American steamship *Constance Chandler* encountered gales of force 10, the former from south-southeast and the latter from southwest, with considerable depression of the barometer within the area of approximately 13° N., 92½° W. Following the 9th the cyclone system apparently disorganized, as is frequently the case in these waters. Conditions remained disturbed south of the Gulf of Tehuantepec until the 12th, on which date the American steamship *Ensley City* experienced a north gale of force 8, barometer 29.67. However, on the 11th, lowered pressures and heavy rains over Guatemala and southern Mexico indicated some movement of the disturbed condition across Central America to the western Caribbean where a moderate cyclone developed as described elsewhere in this issue of the REVIEW.

On the 22d a further apparently immature storm development occurred at some distance south of Acapulco; but the only available evidence of its existence is that contained in the report of the steamship *Steel Ranger*, which shows that a southwest gale of force 8 was experienced, with accompanying barometer depressed to 29.49 inches, in 13°58′ N., 102°17′ W.

Fog.—As is usual in June in these waters, frequent fog occurred along the western half of the northern trans-Pacific routes, the percentage ranging from about 20 in upper midocean, to 60 off the east coast of Hokushu Island. Some fog was also met along most of the length of the middle routes. Along the American coast there were 6 days with fog off southern California, and 14 days with fog off Lower California.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, June 1936

[For description of tables and charts, see REVIEW, January p. 29]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	81.1	+2.8	Decatur	107	29	St. Bernard	45	1	1.91	−2.29	Valley Head	6.72	Cordova	0.17
Arizona	79.7	+2.8	Gila Bend	121	25	Fort Valley	23	[1] 1	.19	−.15	Fort Valley	1.66	19 stations	.00
Arkansas	80.0	+2.9	Corning	113	20	2 stations	44	[1] 14	1.26	−2.76	Higden	4.02	3 stations	T
California	67.9	−.3	Cow Creek	124	21	Ellery Lake	13	1	.81	+.47	Upper Mattole	4.91	32 stations	.00
Colorado	66.1	+4.5	Las Animas	112	18	2 stations	21	[1] 1	1.41	+.01	Silver Lake	3.99	La Veta Pass	.02
Florida	79.3	−.5	Lake City	102	18	Cottage Hill	53	1	8.01	+1.33	Everglades	24.73	Mt. Pleasant	1.21
Georgia	79.3	+1.5	2 stations	106	29	Blairsville	36	1	3.00	−1.39	Douglas	8.52	Tallapoosa	.60
Idaho	63.4	+3.0	Lapwai	110	22	Bakers Ranch	22	10	2.05	+.76	Roland	5.85	Bakers Ranch	.21
Illinois	72.8	+1.2	4 stations	106	[1] 19	Ottawa	38	12	1.66	−2.39	Morrison	4.85	Watseka	.09
Indiana	71.8	+.3	2 stations	111	29	Wheatfield	38	12	1.37	−2.39	Wabash	3.48	2 stations	.20
Iowa	70.1	+.5	Logan	108	29	4 stations	37	3	2.85	−1.77	Clinton	6.36	Glenwood	1.06
Kansas	77.3	+3.5	2 stations	114	26	2 stations	44	[1] 3	1.26	−2.74	Coffeyville	5.57	Wagstaff	.09
Kentucky	76.1	+2.2	St. John	110	29	Quicksand	40	1	.81	−3.31	Barbourville	4.88	Mount Sterling	T
Louisiana	81.9	+1.8	Dodson	110	20	Urania	50	1	.53	−4.03	Delta Farms	2.05	10 stations	.00
Maryland-Delaware	70.9	+.1	Keedysville, Md.	99	3	2 stations	34	5	3.19	−.85	Frostburg, Md.	6.80	Coleman, Md.	1.12
Michigan	62.3	−1.7	Morenci	96	17	Newberry	26	3	2.00	−1.07	Milford	4.31	Roscommon (near)	.49
Minnesota	63.9	−.5	Canby	105	25	Big Falls	29	10	1.87	−2.15	Itasca State Park	4.11	Moorhead	.48
Mississippi	81.5	+2.7	Greenwood	111	20	Tunica	49	1	1.36	−2.78	Merrill	3.50	Columbia	.00
Missouri	76.5	+2.9	Doniphan	112	20	Goodland	40	13	1.42	−3.19	Salem	4.86	Waverly	.07
Montana	63.9	+4.1	Jordan	111	27	Outlook	25	4	1.78	−.70	Norris (near)	4.61	Brunelda	.05
Nebraska	72.7	+3.6	2 stations	114	26	3 stations	32	3	2.01	−1.66	Wahoo	4.49	Alma	.60
Nevada	68.4	+4.0	Logandale	117	21	Sharp	26	4	.79	+.29	Lamoille	3.16	5 stations	.00
New England	64.6	+.6	2 stations	95	3	Somerset, Vt.	30	17	3.01	−.38	New Haven, Conn.	13.96	St. Johnsbury, Vt.	.66
New Jersey	69.1	+.3	Phillipsburg	99	3	2 stations	38	6	4.93	+1.22	Little Falls	8.13	Tuckerton	2.28
New Mexico	70.7	+1.8	Carlsbad	108	9	do	20	[1] 3	.94	−.29	Miami	3.17	Rodeo	.00
New York	65.6	+.6	Bedford Hills	100	3	Indian Lake	27	11	2.51	−1.12	Setauket	7.71	Skaneateles	.22
North Carolina	74.2	+.3	3 stations	105	[1] 29	Banners Elk	32	1	4.20	−.48	Smithfield	8.50	Mount Mitchell	.60
North Dakota	66.4	+3.9	2 stations	110	24	Cavalier	28	2	1.54	−2.07	Maddock	4.73	Valley City	.12
Ohio	70.3	+.8	Gallipolis (near)	105	[1] 17	Millport	37	5	1.74	−2.00	Medina (near)	4.18	Chilo	.22
Oklahoma	80.8	+3.6	Cloud Chief	114	22	Smithville	47	15	1.97	−1.82	Union City	9.11	Idabel	.03
Oregon	61.6	+2.0	Danner	106	22	Fremont	22	1	1.87	+.65	Zigzag	7.33	Umatilla	.31
Pennsylvania	68.5	+.4	Phoenixville	100	3	2 stations	33	5	3.80	−.30	Quakertown	12.01	Clairton	1.05
South Carolina	77.7	+.2	2 stations	105	29	Long Creek (near)	40	1	3.66	−1.05	McCool	9.72	Effingham	1.54
South Dakota	71.4	+4.8	Cottonwood	114	18	Wentworth	30	3	1.32	−2.05	Custer	4.91	Faith	.00
Tennessee	78.2	+3.5	Etowah	110	29	Rugby	35	1	1.04	−3.15	Perryville	4.11	Lock No. 6	.00
Texas	82.1	+1.9	Snyder	113	22	2 stations	47	[1] 4	1.59	−1.37	Eagle Pass	16.38	15 stations	.00
Utah	67.9	+3.3	Moab	113	17	Heber	25	9	1.21	+.64	Fillmore	4.48	Leeds (near)	T
Virginia	72.1	+.5	2 stations	105	30	Burkes Garden	34	1	3.38	−.75	Holland	7.45	Emory	.72
Washington	62.2	+1.5	Wawawai	109	22	Bumping Lake	30	18	3.39	+1.88	Quinault	10.79	Kennewick	.29
West Virginia	70.5	+.9	Hastings	105	17	Brownville	32	2	2.41	−1.91	Harpers Ferry	5.34	Dam No. 19 O. R.	.37
Wisconsin	62.8	−2.3	Brodhead	96	26	Cornucopia	27	2	2.29	−1.72	Hancock	4.51	Manitowoc	.79
Wyoming	63.0	+4.3	Colony	109	25	Afton (near)	20	[1] 1	1.82	+.22	Dome Lake	4.49	Kemmerer	.11
Alaska (May)	43.9	+2.2	Haines	83	31	2 stations	−14	1	1.69	+.20	Cordova	20.56	2 stations	T
Hawaii	74.0	+.7	5 stations	91	[1] 17	Kanolohuluhulu	47	10	4.48	−.58	Kailua (Mauka)	19.40	6 stations	.00
Puerto Rico	78.2	+.4	3 stations	95	[1] 1	Guineo Reservoir	47	19	7.82	+1.58	La Mina	19.52	Mona Island	.70

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau Stations, June 1936*

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*		*° F.*	*° F.*		*° F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0-10*	*In.*	*In.*
New England							64.0	+0.5										73	3.80	+0.8										6.0		
Eastport	76	67	85	29.81	29.89	−0.04	55.7	+0.6	75	6	64	42	6	48	33	53	51	87	4.07	+1.1	12	6,146	sw.	24	nw.	16	4	8	18	7.2	0.0	0.0
Greenville, Maine	1,070	6	40	28.74	29.89	------	61.2	------	82	6	72	39	23	50	36	----	----	----	3.44	------	12	3,748	se.	20	-----	1	8	10	12	----	.0	.0
Portland, Maine	103	82	117	29.78	29.90	−.05	62.9	+.4	78	28	71	45	30	55	27	56	52	71	2.68	−.6	10	6,115	s.	28	nw.	29	12	11	7	4.7	.0	.0
Concord	289	60	----	------	------	------	65.2	+2.3	92	3	77	42	31	54	38	----	----	----	1.99	−1.2	8	------	nw.	----	----	----	8	13	9	----	.0	.0
Burlington	403	11	48	29.45	29.88	−.08	64.6	−1.1	86	10	75	42	30	54	33	57	51	64	1.51	−1.9	6	6,299	s.	30	s.	18	7	10	13	5.9	.0	.0
Northfield	876	12	60	28.97	29.90	−.06	62.2	+.9	87	2	75	35	22	49	43	57	52	67	2.12	−1.1	8	5,627	s.	27	sw.	2	6	13	11	6.1	.0	.0
Boston [1]	29	31	50	29.87	29.90	−.06	66.2	−.3	85	26	74	52	17	58	30	60	55	71	2.37	−.5	9	7,207	sw.	28	w.	20	6	10	14	6.2	.0	.0
Nantucket	12	14	90	29.90	29.91	−.07	62.4	+1.4	76	19	68	52	7	57	22	59	57	88	3.59	+.9	10	10,719	sw.	52	ne.	24	7	11	12	6.0	.0	.0
Block Island	26	11	46	29.89	29.92	−.05	63.1	+1.3	76	21	68	53	11	58	19	59	58	87	3.56	+.9	10	9,999	sw.	38	ne.	24	7	11	12	6.6	.0	.0
Providence	100	215	251	29.75	29.92	−.05	67.0	−1.3	85	26	76	53	17	58	28	60	55	70	2.92	+.2	10	7,578	nw.	29	nw.	28	9	11	10	5.7	.0	.0
Hartford	189	70	104	29.74	29.91	−.06	67.8	+.7	88	3	77	49	17	58	31	----	----	----	3.05	.0	10	5,779	s.	24	sw.	1	10	9	11	5.6	.0	.0
New Haven	106	74	153	29.81	29.92	−.05	66.9	+.3	88	26	74	52	17	59	27	60	56	71	13.96	+10.9	12	6,305	n.	25	ne.	24	7	12	11	6.2	.0	.0
Middle Atlantic States							70.6	+0.3										69	3.70	+0.1										5.7		
Albany	97	97	112	29.80	29.90	−.07	69.2	+1.2	89	2	79	49	17	60	32	60	54	63	1.86	−1.5	11	5,792	s.	24	s.	2	8	14	8	5.6	.0	.0
Binghamton	871	57	79	29.01	29.93	−.04	67.0	+1.4	89	26	78	42	23	56	40	----	----	----	3.07	−.3	9	4,319	nw.	21	sw.	1	6	8	16	6.8	.0	.0
New York	314	415	454	29.58	29.92	−.06	68.6	−.2	89	3	76	55	1	61	25	61	56	70	4.17	+.8	12	9,105	n.	49	nw.	3	9	7	14	6.0	.0	.0
Harrisburg	374	94	104	29.52	29.91	−.08	70.4	+.1	93	3	80	52	24	61	32	62	56	64	4.61	+1.0	12	5,199	ne.	25	sw.	18	10	11	9	5.3	.0	.0
Philadelphia	114	174	367	29.81	29.93	−.05	71.8	+.4	93	3	80	55	24	63	26	63	58	67	3.96	+.7	11	8,575	n.	33	s.	18	12	5	13	5.7	.0	.0
Reading	325	283	306	29.57	29.91	------	70.1	+.3	93	3	79	52	24	61	28	61	56	64	5.76	+2.2	10	7,466	se.	36	nw.	3	9	7	14	5.9	.0	.0
Scranton	805	72	104	29.07	29.92	−.06	68.0	+.2	90	3	78	46	6	58	37	60	54	63	6.75	+3.1	9	4,638	sw.	28	nw.	3	7	16	7	5.3	.0	.0
Atlantic City	52	37	172	29.87	29.92	−.06	67.2	+.6	90	21	73	57	25	62	25	62	60	81	4.50	+1.5	13	10,651	s.	40	se.	18	4	7	19	7.2	.0	.0
Sandy Hook	22	10	57	29.90	29.92	------	68.3	+.5	88	3	75	57	9	62	24	62	59	77	4.25	+.5	11	8,874	s.	32	s.	17	13	5	12	5.2	.0	.0
Trenton	190	88	106	29.72	29.92	------	69.9	+.4	94	3	79	53	23	60	31	62	57	68	2.39	−.7	11	6,706	n.	35	nw.	3	9	9	12	5.9	.0	.0
Baltimore	123	100	215	29.79	29.92	−.07	73.2	+.5	96	3	82	55	24	65	28	64	60	64	1.48	−2.4	13	7,422	sw.	32	nw.	3	12	8	10	5.2	.0	.0
Washington	112	62	85	29.80	29.92	−.08	72.8	+.6	96	3	83	54	24	63	32	64	58	65	2.29	−1.8	10	4,462	sw.	32	nw.	11	11	8	13	5.7	.0	.0
Cape Henry	18	8	54	29.91	29.93	------	73.0	+.1	103	30	81	57	6	66	32	67	64	77	3.81	−.2	10	7,916	sw.	44	nw.	4	13	9	8	4.9	.0	.0
Lynchburg	686	5	----	29.22	29.95	−.06	73.6	−1.0	103	30	86	46	1	61	44	----	----	----	4.64	+.8	15	------	ne.	----	----	----	11	18	1	----	.0	.0
Norfolk	91	80	125	29.84	29.94	−.06	74.0	−.4	101	30	82	58	1	66	29	66	62	72	3.95	−.3	12	6,725	sw.	31	ne.	30	10	8	12	5.6	.0	.0
Richmond	144	11	52	29.79	29.94	−.07	74.2	+.1	104	30	85	53	1	64	35	65	61	69	3.88	.0	12	5,724	sw.	23	ne.	30	10	10	10	5.1	.0	.0
Wytheville	2,304	49	55	------	29.90	−.11	69.4	+.7	95	29	82	42	1	57	40	----	----	66	1.67	−2.5	12	4,138	w.	26	nw.	30	13	11	6	----	.0	.0
South Atlantic States							77.3	+0.9										71	3.57	−1.1										4.2		
Asheville	2,253	89	104	27.66	29.92	−.09	72.4	+3.7	98	29	85	44	1	60	39	62	57	65	2.58	−1.4	9	4,724	s.	27	ne.	18	14	10	6	4.2	.0	.0
Charlotte	779	63	86	29.12	29.94	−.07	77.4	+1.9	101	30	88	55	24	67	28	66	61	62	3.20	−1.0	6	5,254	sw.	21	sw.	30	10	12	8	4.3	.0	.0
Greensboro	886	6	56	29.00	29.94	------	74.0	------	101	30	86	48	1	62	39	66	62	70	3.79	------	12	5,873	ne.	31	ne.	18	13	10	7	4.6	.0	.0
Hatteras	11	5	50	------	29.94	−.07	74.9	−.7	88	30	80	61	26	70	17	----	----	76	2.76	−1.8	10	8,148	sw.	28	w.	29	11	11	8	----	.0	.0
Raleigh	376	103	146	29.54	29.92	−.09	75.4	−.3	101	30	86	54	25	65	29	67	63	71	8.07	+3.7	10	6,125	sw.	34	w.	18	15	6	9	4.5	.0	.0
Wilmington	72	73	107	29.88	29.95	−.06	76.5	−.3	95	30	85	60	6	68	24	70	67	77	3.57	−1.5	6	6,430	s.	24	s.	18	14	11	5	3.8	.0	.0
Charleston	48	11	92	29.90	29.95	−.06	78.8	−.1	99	28	85	63	25	72	25	72	69	75	3.08	−1.5	9	7,020	s.	28	ne.	4	15	7	8	4.4	.0	.0
Columbia, S. C	347	67	73	29.57	29.94	−.07	79.2	+1.1	103	29	90	59	24	69	28	68	64	66	1.55	−2.6	11	4,773	s.	18	w.	30	16	9	5	3.6	.0	.0
Greenville, S. C	1,039	139	----	------	------	------	77.0	+2.9	100	30	87	56	24	67	27	----	----	----	2.80	−1.8	6	------	w.	----	----	----	12	9	9	----	.0	.0
Augusta	182	62	77	29.73	29.92	−.09	79.8	+1.1	105	29	91	57	1	69	31	70	65	67	1.92	−2.8	11	4,362	s.	29	n.	8	11	12	7	4.6	.0	.0
Savannah	65	73	152	29.87	29.94	−.07	80.0	+1.0	100	29	89	64	25	71	28	72	69	75	3.57	−1.7	11	6,836	s.	36	se.	19	16	10	4	3.6	.0	.0
Jacksonville	43	86	110	29.90	29.95	−.06	79.0	−.9	96	29	87	65	27	71	24	72	69	76	6.15	+.8	14	5,348	s.	26	e.	3	13	11	6	4.3	.0	.0
Florida Peninsula							80.1	−0.6										79	12.18	+6.1										5.8		
Key West	22	10	64	29.88	29.90	−0.09	81.2	−.7	90	29	87	72	20	76	15	76	74	80	10.45	+6.2	19	6,617	se.	32	w.	15	4	16	10	6.1	.0	.0
Miami	25	124	168	29.90	29.93	−.07	79.0	−1.0	90	30	84	68	8	74	20	74	72	80	21.41	+14.6	20	6,750	se.	39	ne.	15	5	9	16	6.9	.0	.0
Tampa	35	88	197	29.89	29.93	−.08	80.0	−.2	92	19	88	68	8	72	22	72	70	77	4.69	−2.6	14	7,086	e.	32	e.	3	13	11	6	4.3	.0	.0
Titusville	43	5	36	29.89	29.94	------	77.8	------	96	30	87	64	8	69	27	----	----	----	10.16	------	15	------	se.	----	----	----	11	11	8	----	.0	.0
East Gulf States							81.3	+2.7										67	2.14	−2.5										2.8		
Atlanta [1]	976	5	53	28.92	29.90	−.11	79.4	+3.4	102	17	92	54	1	67	36	68	62	61	3.17	−.6	7	5,308	sw.	35	nw.	3	12	14	4	4.1	.0	.0
Macon	370	79	87	29.53	29.92	−.09	79.4	+.5	102	29	91	55	1	68	33	70	66	68	2.56	−1.5	8	4,598	s.	29	nw.	7	12	16	2	4.1	.0	.0
Thomasville	273	49	58	29.65	29.94	−.06	80.1	+.6	97	29	91	63	2	69	29	72	70	77	2.95	−2.5	8	------	sw.	----	----	----	10	16	4	----	.0	.0
Apalachicola	35	11	----	29.89	29.93	------	79.9	------	92	17	87	67	3	73	22	74	----	----	3.64	−2.0	11	------	sw.	----	----	----	10	18	2	----	.0	.0
Pensacola	56	149	185	29.87	29.93	−.06	80.5	+1.2	94	20	86	67	8	75	22	74	71	76	1.48	−3.2	6	8,015	sw.	53	se.	8	22	8	0	2.3	.0	.0
Anniston	741	9	----	------	------	------	81.0	+6.0	102	29	95	52	2	67	40	----	----	----	.95	−3.2	5	------	se.	----	----	----	16	12	2	----	.0	.0
Birmingham	700	11	48	29.16	29.91	−.08	81.8	+3.9	101	19	94	59	1	70	30	68	62	58	1.81	−2.6	6	4,403	sw.	30	se.	8	21	8	1	2.5	.0	.0
Mobile	57	86	105	29.56	29.92	−.07	82.6	+2.3	102	20	92	60	1	73	25	72	70	71	1.75	−3.7	4	5,371	s.	26	se.	8	19	11	0	2.8	.0	.0
Montgomery	218	92	105	29.69	29.93	−.07	82.2	+2.6	99	20	93	60	1	71	28	71	66	64	4.14	+.3	5	4,782	sw.	32	sw.	8	18	11	1	2.8	.0	.0
Meridian	375	67	92	29.53	29.91	−.07	81.4	+3.3	101	20	94	54	1	69	32	70	65	69	1.71	−2.8	3	4,032	sw.	21	nw.	10	27	2	1	1.5	.0	.0
Vicksburg	247	65	73	29.67	29.92	−.05	81.6	+2.6	100	20	92	61	1	71	30	71	66	65	.87	−3.1	3	4,801	n.	18	ne.	3	25	2	3	1.9	.0	.0
New Orleans	53	76	84	29.87	29.92	−.06	83.8	+3.2	98	16	92	68	1	76	25	74	71	68	.71	−3.2	5	4,560	sw.	24	ne.	10	13	16	1	3.5	.0	.0
West Gulf States							82.3	+2.6										65	1.75	−1.9										2.9		
Shreveport	249	92	227	29.65	29.91	−.05	83.8	+3.1	104	20	95	65	25	72	28	70	64	57	.39	−3.1	4	7,129	s.	35	ne.	10	21	7	2	2.5	.0	.0
Bentonville	1,303	12	38	28.58	29.91	−.03	77.9	−3.8	102	22	91	52	4	65	38	----	----	----	1.59	−3.7	4	4,312	sw.	20	sw.	1	20	7	3	----	.0	.0
Fort Smith	457	79	94	29.42	29.88	−.06	82.2	+4.7	106	20	95	61	2	69	33	67	59	51	2.39	−1.3	4	5,458	sw.	47	nw.	2	20	8	2	2.7	.0	.0
Little Rock	357	94	102	29.54	29.90	−.06	80.6	+3.2	105	20	92	62	25	70	29	68	62	58	3.27	−.5	3	6,159	sw.	29	ne.	10	19	8	3	2.7	.0	.0
Austin	605	136	148	29.26	29.89	------	83.1	+1.9	106	21	93	64	1	73	32	72	67	65	3.30	+.9	3	5,534	se.	22	ne.	11	17	10	3	3.4	.0	.0
Brownsville	57	88	96	29.78	29.84	------	83.1	+.7	96	15	91	71	1	76	23	75	73	80	.66	−2.2	3	7,451	se.	26	se.	29	19	10	1	3.3	.0	.0
Corpus Christi	20	11	78	29.85	29.87	−.04	82.9	+1.9	95	21	89	71	27	77	19	76	73	77	3.05	+.5	7	7,876	se.	49	n.	27	20	6	4	3.3	.0	.0
Dallas	512	220	227	29.34	29.87	------	84.1	------	105	21	94	66	1	74	28	69	63	56	T	−3.9	0	8,096	s.	34	n.	10	21	8	1	2.1	.0	.0
Fort Worth	679	92	110	29.20	29.90	−.02	84.0	+4.1	107	21	95	66	15	73	32	----	----	----	.03	−3.3	1	6,918	s.	25	s.	29	23	7	0	2.0	.0	.0
Galveston	54	106	114	29.85	29.91	−.04	83.1	+2.4	94	14	88	70	11	78	24	75	73	74	.88	−3.5	3	7,505	s.	35	e.	11	20	10	0	2.1	.0	.0
Houston	138	292	314	29.77	29.91	------	82.8	+1.4	98	21	92	68	1	74	26	----	----	----	.53	−4.0	3	7,831	s.	30	ne.	11	17	11	2	3.7	.0	.0
Palestine	510	64	72	29.39	29.91	−.03	82.1	+3.1	103	21	93	64	1	72	29	71	66	62	.92	−2.7	2	5,208	s.	20	s.	30	20	9	1	2.7	.0	.0
Port Arthur	34	58	66	29.87	29.91	------	83.6	------	98	15	91	68	11	76	28	75	71	71	1.07	−3.7	2	5,563	s.	25	ne.	11	17	12	1	3.0	.0	.0
San Antonio	693	242	301	29.16	29.86	−.04	82.4	+1.4	106	21	92	65	1	73	29	72	68	68	6.43	+4.0	5	7,578	ne.	43	ne.	24	11	15	4	4.6	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, June 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							75.1	+2.3										53	1.46	−2.5										3.8		
Chattanooga	762	71	214	29.92	29.90	−.10	81.7	+6.3	102	29	94	55	1	69	34	67	60	52	1.92	−2.2	9	5,389	w.	31	w.	7	18	11	1	3.0	.0	.0
Knoxville	995	66	84	28.88	29.90	−.10	79.7	+5.7	101	29	92	51	1	67	37	65	57	50	1.39	−2.7	5	4,317	ne.	27	w.	7	22	7	1	2.5	.0	.0
Memphis	399	78	86	29.48	29.90	−.07	80.6	+3.0	103	20	90	66	24	71	25	68	60	54	1.22	−2.3	4	5,941	w.	30	w.	7	21	5	4	2.4	.0	.0
Nashville	546	168	188	29.35	29.92	−.07	79.8	+4.2	101	28	92	53	1	68	35	64	55	47	.21	−3.8	2	6,609	sw.	27	nw.	18	18	8	4	3.2	.0	.0
Lexington	989	6	----	----	----	----	76.0	+3.8	104	29	90	53	1	62	40	----	----	----	1.18	−2.9	4	----	n.	----	----	----	22	8	0	----	.0	.0
Louisville	525	188	234	29.36	29.93	−.05	76.6	+1.9	102	29	88	53	4	65	33	63	53	48	.35	−3.5	5	7,512	n.	35	sw.	7	22	3	5	2.9	.0	.0
Evansville	431	76	116	29.46	29.92	−.05	77.1	+2.0	103	29	89	55	4	65	32	63	54	46	1.39	−2.6	5	6,461	n.	37	sw.	30	16	10	4	3.7	.0	.0
Indianapolis	822	194	230	29.06	29.93	−.04	72.0	+.4	98	29	84	52	12	60	39	60	51	51	2.91	−.7	8	7,812	ne.	29	s.	6	13	11	6	4.5	.0	.0
Terre Haute	575	63	149	29.30	29.91	----	74.4	----	103	29	88	52	3	61	39	61	52	48	1.05	−2.9	6	7,116	ne.	28	sw.	1	15	12	3	3.7	.0	.0
Cincinnati	627	11	51	29.76	29.92	−.07	74.2	+3.0	98	30	87	50	4	62	40	62	54	55	.80	−2.9	7	5,005	n.	26	w.	30	15	9	6	4.4	.0	.0
Columbus	822	90	210	29.06	29.92	−.07	72.0	+1.1	97	17	84	50	4	60	33	60	53	55	2.23	−1.1	8	6,403	n.	35	sw.	2	13	13	2	4.1	.0	.0
Dayton	900	58	153	28.98	29.91	----	72.4	+1.0	97	17	84	50	4	60	33	----	----	----	.52	−3.3	5	5,908	n.	33	sw.	2	13	12	5	4.4	.0	.0
Elkins	1,947	59	78	27.95	29.94	−.06	66.4	−.5	92	17	80	40	5	53	43	59	54	69	3.05	−2.0	8	3,772	n.	32	nw.	30	9	16	5	5.4	.0	.0
Parkersburg	637	77	84	29.30	29.95	−.05	73.2	+1.8	98	17	85	48	25	61	39	62	55	56	2.07	−1.9	5	4,513	nw.	30	nw.	30	12	14	4	4.3	.0	.0
Pittsburgh [1]	842	164	410	28.58	29.91	−.08	69.4	−1.3	93	17	80	49	4	58	32	59	53	61	1.61	−2.2	11	6,876	nw.	32	nw.	17	11	10	9	5.3	.0	.0
Lower Lake Region							66.7	0.0										63	2.12	−1.2									5.0		
Buffalo	768	243	280	29.10	29.91	−0.06	65.4	+1.0	89	10	73	49	3	57	29	59	55	71	1.08	−1.7	9	8,768	sw.	50	w.	17	14	10	6	4.7	0.0	0.0
Canton	448	10	61	29.41	29.88	----	64.2	−1.6	88	9	75	39	30	53	36	58	53	66	4.24	+1.0	11	5,293	w.	30	sw.	2	9	10	11	5.7	.0	.0
Ithaca	836	77	100	29.02	29.91	----	66.1	−.1	88	2	78	42	23	54	42	58	53	63	1.54	−2.0	8	6,056	nw.	28	se.	18	9	12	9	5.5	.0	.0
Oswego	335	71	85	29.54	29.90	−.07	63.8	−1.0	85	10	73	46	5	54	35	57	5	69	.70	−2.6	6	5,575	w.	20	w.	28	8	14	8	5.5	.0	.0
Rochester	523	86	102	29.36	29.92	−.05	67.3	+1.2	91	17	78	48	22	57	37	58	51	58	2.30	−.7	7	5,460	sw.	27	sw.	1	14	10	6	4.3	.0	.0
Syracuse	596	65	79	29.29	29.93	−.04	68.2	+2.6	91	2	78	47	22	58	37	----	----	----	.57	−3.3	10	5,212	s.	21	w.	28	8	13	9	6.0	.0	.0
Erie	714	130	166	29.17	29.93	−.05	67.2	+1.0	90	17	76	48	4	59	31	59	54	64	1.75	−1.6	13	7,872	n.	32	sw.	2	14	11	5	4.2	.0	.0
Cleveland	762	267	318	29.12	29.93	−.05	66.2	−.9	90	17	74	49	3	58	36	58	52	62	2.32	−.8	7	8,876	n.	51	nw.	2	7	16	7	5.0	.0	.0
Sandusky	629	5	67	29.27	29.94	−.04	68.6	−.2	94	17	78	49	4	59	34	----	----	----	2.05	−1.4	12	5,717	ne.	30	nw.	2	9	13	8	4.9	.0	.0
Toledo	628	208	87	29.27	29.94	−.03	68.1	−.6	93	17	78	48	16	58	36	59	52	60	2.31	−1.0	8	6,270	n.	35	nw.	17	11	14	5	4.5	.0	.0
Fort Wayne	857	100	84	29.02	29.93	----	69.2	+.7	93	17	80	50	4	58	33	59	51	55	2.65	−.9	8	5,864	nw.	29	sw.	1	11	14	5	4.7	.0	.0
Detroit [1]	626	5	78	29.27	29.94	−.03	65.8	−1.6	88	25	77	46	16	54	34	5	51	63	3.87	+.3	9	6,185	nw.	27	s.	17	11	11	8	4.9	.0	.0
Upper Lake Region							60.5	−1.9										66	1.50	−1.9									5.1		
Alpena	609	13	89	29.29	29.95	−.01	58.8	−1.6	88	25	69	39	3	49	31	53	48	69	1.33	−2.0	6	7,120	nw.	26	nw.	28	16	9	5	4.1	.0	.0
Escanaba	612	54	60	29.30	29.96	+.02	57.2	−3.5	79	14	67	41	21	48	31	52	47	69	1.23	−2.0	7	7,346	s.	29	n.	14	10	8	12	5.4	.0	.0
Grand Rapids	707	70	244	29.18	29.94	−.03	67.2	−.6	90	26	79	45	3	58	37	57	50	60	2.35	−1.1	6	6,689	ne.	31	s.	1	11	11	8	4.7	.0	.0
Lansing	878	5	90	29.01	29.94	----	64.2	−2.2	85	17	76	44	3	53	32	58	53	67	2.98	−.5	7	5,344	n.	23	w.	17	9	13	8	4.6	.0	.0
Ludington	637	5	54	29.26	29.96	----	58.6	−1.9	80	26	68	39	22	49	30	52	----	----	.99	−1.9	5	----	n.	----	----	----	15	11	4	----	.0	.0
Marquette	734	77	111	29.16	29.96	+.02	56.8	−2.1	82	13	66	40	8	47	33	51	46	68	1.41	−1.8	12	5,656	nw.	30	sw	13	6	15	9	5.8	.0	.0
Sault Sainte Marie	614	11	52	29.27	29.96	.00	56.6	−2.0	81	24	68	36	2	45	38	51	46	71	1.03	−1.9	9	5,023	w.	24	nw.	20	11	9	10	4.9	.0	.0
Chicago	673	7	131	29.24	29.96	.00	64.6	−2.7	95	26	73	48	2	56	35	56	50	65	1.03	−2.3	9	7,052	ne.	29	sw.	1	13	8	9	4.8	.0	.0
Green Bay	617	109	141	29.28	29.94	−.01	62.4	−2.5	88	27	74	40	3	51	33	55	48	62	1.24	−2.5	8	7,406	s.	31	sw.	17	8	13	9	5.7	.0	.0
Milwaukee	681	97	221	29.22	29.96	+.01	62.0	−1.9	91	26	71	43	2	53	36	54	47	60	1.93	−1.5	8	8,317	n.	35	w.	17	10	8	12	5.4	.0	.0
Duluth	1,133	5	47	28.73	29.94	+.02	57.6	+.4	87	24	68	39	8	47	40	51	46	68	.93	−3.0	10	8,502	ne.	35	nw.	14	8	12	10	5.7	.0	.0
North Dakota							66.4	+3.2										54	1.14	−2.5									4.6		
Moorhead, Minn.	940	50	58	28.90	29.90	.00	65.6	+1.2	99	24	78	39	2	54	42	56	49	57	.48	−3.6	8	6,669	s.	24	se.	18	8	12	10	5.5	.0	.0
Bismarck	1,674	8	87	28.12	29.87	.00	69.2	+5.5	105	24	83	42	9	56	39	56	45	48	.47	−2.9	6	7,367	se.	34	se.	7	15	10	5	3.9	.0	.0
Devils Lake	1,478	11	44	28.36	29.91	+.03	64.0	+2.1	101	24	77	36	2	51	42	55	48	62	2.13	−1.4	10	6,686	s.	28	nw.	13	10	12	8	5.0	.0	.0
Grand Forks	833	12	67	----	----	----	64.2	----	97	24	78	37	2	51	42	56	----	----	2.26	----	8	----	nw.	28	se	18	7	21	2	----	.0	.0
Williston	1,878	42	50	27.92	29.86	.00	66.7	+4.0	104	24	80	36	9	54	41	54	44	50	1.47	−2.0	6	6,670	se.	32	nw.	16	14	11	5	3.9	.0	.0
Upper Mississippi Valley							71.1	+0.5										57	2.18	−1.9									4.6		
Minneapolis	919	105	208	28.97	29.94	----	66.4	−1.1	95	16	76	46	2	56	39	57	49	57	2.29	−1.9	10	7,377	n.	32	w.	16	6	12	12	6.1	.0	.0
La Crosse	714	11	48	29.17	29.93	.00	67.2	−1.1	90	26	78	45	11	56	35	58	53	64	2.06	−2.0	8	3,529	s.	22	nw.	16	9	11	10	5.5	.0	.0
Madison	974	70	78	28.91	29.93	−.01	65.4	−1.8	88	26	75	44	2	56	36	58	52	64	2.24	−1.5	11	5,502	ne.	22	sw.	17	10	7	13	5.8	.0	.0
Charles City	1,015	10	51	28.88	29.93	+.02	67.4	+.9	96	29	79	43	3	55	35	59	52	61	1.62	−3.0	7	4,838	n.	21	s.	16	12	11	7	4.6	.0	.0
Davenport	606	66	161	29.28	29.93	−.01	71.4	+.9	104	29	83	50	2	60	44	60	54	58	2.32	−1.8	8	6,827	ne.	46	nw.	29	12	9	9	4.9	.0	.0
Des Moines	861	5	99	29.03	29.92	.00	71.4	+.8	100	29	83	48	4	60	37	61	54	58	3.81	−1.0	10	6,811	n.	42	nw.	9	15	9	6	4.2	.0	.0
Dubuque	699	60	79	29.20	29.93	.00	68.6	−.8	97	26	79	48	4	58	36	59	52	58	3.66	−.6	10	4,299	s.	24	nw.	16	13	8	9	5.0	.0	.0
Keokuk	614	64	78	29.28	29.92	−.02	74.0	+1.5	104	19	86	50	22	62	43	62	53	52	1.26	−2.9	8	5,511	ne.	28	nw.	9	13	8	9	4.8	.0	.0
Cairo	358	87	93	29.53	29.90	−.07	78.2	+1.9	101	19	90	58	22	67	29	66	60	59	2.18	−1.6	5	6,075	n.	27	w.	7	16	8	6	3.7	.0	.0
Peoria	609	11	45	29.29	29.95	.00	72.0	+1.1	105	29	86	43	3	58	44	60	53	54	.45	−3.3	4	4,815	ne.	27	nw.	9	15	11	4	3.4	.0	.0
Springfield, Ill.	636	5	191	29.26	29.92	−.03	74.2	+2.0	103	29	87	51	3	61	43	61	52	51	1.14	−2.9	7	7,754	n.	38	nw.	9	16	8	6	4.0	.0	.0
St. Louis	568	179	303	29.32	29.91	−.04	77.2	+2.2	104	19	88	55	22	66	36	63	55	50	3.07	−.8	7	7,915	ne.	35	sw.	1	20	7	3	2.7	.0	.0
Missouri Valley							75.1	+3.9										54	1.72	−2.7									3.2		
Columbia, Mo.	784	6	84	29.09	29.90	−0.05	76.3	+3.5	105	19	89	50	24	64	36	----	----	----	.27	−4.5	3	6,066	sw.	27	sw.	1	16	10	4	3.5	0.0	0.0
Kansas City [1]	750	32	45	29.10	29.88	−.04	78.4	+4.8	107	19	92	51	3	65	40	64	55	49	.51	−4.5	3	7,333	sw.	34	sw.	1	19	9	2	2.9	.0	.0
St. Joseph	967	11	49	28.88	29.89	----	76.0	----	105	19	88	51	3	63	37	63	56	55	3.68	−1.3	5	6,295	e.	24	sw.	1	24	4	2	2.3	.0	.0
Springfield, Mo.	1,324	98	104	28.54	29.91	−.04	77.6	+5.1	101	20	89	54	4	66	28	64	57	53	2.05	−2.6	7	6,819	s.	37	nw.	10	26	4	0	1.3	.0	.0
Iola	984	11	50	28.88	29.89	−.04	78.4	+4.3	104	20	93	51	3	64	41	----	----	----	1.43	−4.0	4	----	sw.	----	----	----	17	10	3	----	.0	.0
Topeka	987	65	87	----	----	----	78.4	+5.0	109	19	92	50	3	64	40	----	----	----	.92	−3.7	4	6,782	s.	25	sw.	1	22	6	2	2.3	.0	.0
Lincoln	1,189	11	81	28.65	29.88	−.02	74.6	+3.2	108	26	88	46	3	61	38	61	53	52	1.13	−3.2	6	7,499	s.	41	nw.	16	14	13	3	3.9	.0	.0
Omaha [1]	1,105	170	200	28.87	29.90	−.01	73.8	+2.2	105	26	86	50	3	62	35	62	56	57	3.28	−1.3	5	7,824	s.	55	ne.	9	15	10	5	3.8	.0	.0
Valentine	2,598	47	54	27.25	29.91	+.05	71.2	+4.3	104	25	84	38	3	58	42	58	49	52	1.91	−1.0	8	7,438	s.	29	nw.	16	18	9	3	3.8	.0	.0
Sioux City	1,138	64	106	28.71	29.89	−.01	72.3	+2.8	105	25	85	45	3	60	37	60	53	53	2.04	−2.0	7	6,938	s.	67	nw.	26	9	13	8	4.8	.0	.0
Huron	1,307	59	74	28.53	29.90	+.02	70.4	+4.2	109	25	84	40	3	57	47	60	53	58	1.66	−2.1	9	7,860	se.	32	se.	28	15	12	3	3.7	.0	.0
Northern Slope							66.0	+4.7										51	1.70	−0.6											
Havre	2,505	11	67	27.31	29.90	+.05	66.8	+4.8	107	27	80	39	3	53	41	53	42	48	1.55	−1.3	10	6,923	e.	32	w.	28	10	14	6	4.8	.0	.0
Helena	4,124	85	111	25.80	29.93	+.05	62.6	+3.4	96	27	74	34	2	51	37	51	42	52	2.28	−.1	9	6,308	sw.	30	sw.	12	7	12	11	5.8	T	.0
Missoula	3,263	80	91	----	----	----	64.2	+4.2	97	22	77	41	3	52	40	----	----	----	2.05	+.1	12	5,033	nw.	31	w.	15	6	7	17	6.5	.0	.0
Kalispell	2,973	48	56	----	29.92	+.03	61.4	+3.7	93	23	73	38	19	50	41	----	----	62	1.73	−.3	16	4,979	w.	25	w.	23	7	16	7	----	.0	.0
Miles City	2,371	48	55	27.39	29.87	+.02	72.2	+6.2	106	27	85	44	4	59	38	55	42	38	.15	−2.5	6	5,286	n.	31	nw.	12	14	14	2	3.6	.0	.0
Rapid City	3,259	50	58	26.57	29.91	+.06	70.7	+6.5	103	24	84	44	9	58	41	57	46	46	1.21	−2.1	10	6,133	s.	30	w.	15	14	11	5	4.1	.0	.0
Cheyenne	6,094	50	71	24.00	29.88	+.04	65.2	+4.8	95	18	79	39	5	51	39	52	45	57	2.64	+1.0	11	8,205	nw.	51	nw.	15	8	14	8	5.3	.0	.0
Lander	5,372	60	68	24.65	29.87	+.02	66.2	+5.7	95	20	81	41	9	52	40	52	40	46	1.77	+.6	7	4,235	sw.	35	sw.	15	13	11	6	4.2	.0	.0
Sheridan	5,790	10	47	26.06	29.88	----	68.0	----	106	27	83	41	10	53	46	55	44	50	2.18	+.1	9	3,750	nw.	23	nw.	25	14	10	6	3.9	.0	.0
Yellowstone Park	6,241	12	46	23.92	29.97	+.11	58.0	+2.0	88	23	71	33	3	45	40	46	38	56	1.54	−.4	12	5,912	sw.	33	sw.	12	8	10	12	6.0	T	.0
North Platte	2,821	11	51	27.02	29.88	+.02	73.0	+5.5	102	25	86	46	3	60	40	61	54	58	1.64	−1.6	5	5,927	s.	35	ne.	9	13	14	3	3.8	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, June 1936*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Slope							76.4	+4.6										49	0.92	−2.1										3.0		
Denver	5,292	106	113	24.75	29.88	+0.04	71.1	+4.8	99	18	84	47	5	58	42	55	44	47	1.36	.0	9	5,692	s.	30	s.	4	9	16	5	4.9	0.0	0.0
Pueblo	4,685	80	86	25.29	29.85	+.02	74.2	+5.2	104	18	88	51	3	61	40	56	45	44	.62	−.7	7	5,720	e.	34	w.	15	17	11	2	3.4	.0	.0
Concordia	1,392	50	58	28.46	29.90	.00	76.8	+3.8	109	26	90	48	3	64	38	63	55	52	.98	−3.4	6	6,291	s.	26	n.	9	19	9	2	3.0	.0	.0
Dodge City	2,509	10	86	27.36	29.89	+.02	76.6	+4.1	107	26	90	50	3	64	37	62	53	51	1.31	−2.0	4	8,636	s.	50	se.	4	23	6	1	2.0	.0	.0
Wichita	1,358	85	93	28.48	29.86	−.05	79.0	+4.6	105	18	91	53	3	67	34	64	54	47	1.04	−3.3	3	8,215	sw.	43	se.	5	20	6	4	2.5	.0	.0
Oklahoma City	1,214	10	47	28.64	29.88	−.03	80.8	+4.8	107	22	93	57	4	69	33	66	60	55	.23	−3.4	2	6,934	s.	25	s.	5	21	5	4	2.5	.0	.0
Southern Slope							80.5	+2.6										52	1.49	−1.0										2.8		
Abilene	1,738	10	52	28.11	29.86	−.02	83.4	+4.2	105	22	96	63	15	71	34	67	59	51	.01	−3.0	1	7,234	s.	25	se.	4	20	7	3	2.6	.0	.0
Amarillo	3,676	10	49	26.25	29.88	+.03	77.5	+4.7	102	8	90	56	3	66	35	62	54	50	.84	−2.0	4	6,736	s.	28	se.	4	21	9	0	2.1	.0	.0
Del Rio	960	63	71	28.85	29.81	−.04	82.9	−.5	103	21	93	66	24	72	29	71	65	62	4.18	+1.6	5	6,438	se.	27	ne.	24	14	11	5	4.6	.0	.0
Roswell	3,566	75	85	26.33	29.84	+.04	78.2	+1.9	102	9	93	54	6	63	41	61	48	43	.94	−.7	5	5,689	s.	24	sw.	29	20	9	1	1.9	.0	.0
Southern Plateau							77.8	+3.6										34	0.20	−0.2										1.8		
El Paso	3,778	82	101	26.13	29.79	+.04	82.4	+2.8	102	9	95	60	2	70	40	60	44	30	.34	−.2	2	6,451	e.	30	se.	22	25	5	0	1.4	.0	.0
Albuquerque	4,972	5	39	25.04	29.78	------	74.3	------	100	19	92	45	1	57	45	54	38	36	.43	−.1	4	6,694	se.	38	w.	10	19	9	2	2.7	.0	.0
Santa Fe	7,013	38	53	23.33	29.81	.00	68.6	+3.8	93	19	82	43	5	55	36	51	38	39	.42	−.7	5	4,915	se.	20	se.	11	17	12	1	3.3	.0	.0
Flagstaff	6,907	10	59	23.39	29.80	------	63.2	+3.9	93	21	81	28	1	45	45	46	----	40	.26	------	3	6,552	sw.	27	s.	3	11	15	4	----	.0	.0
Phoenix	1,108	10	107	28.60	29.71	−.03	90.3	+5.8	114	13	106	58	1	75	42	62	41	22	T	−.1	0	4,648	w.	27	ne.	25	25	5	0	1.1	.0	.0
Yuma	141	9	54	29.58	29.72	−.02	87.9	+3.2	115	18	104	56	4	71	42	65	50	34	T	.0	0	4,501	w.	27	se.	21	30	0	0	.3	.0	.0
Independence	3,957	5	26	------	------	------	74.3	+2.0	102	21	91	40	4	58	44	52	----	----	.00	−.1	0	-------	nw.	----	------	---	21	5	4	----	.0	.0
Middle Plateau							69.0	+3.6										39	0.77	+0.3										3.9		
Reno	4,527	61	76	25.44	29.87	+0.01	64.6	+2.2	96	22	79	39	2	50	43	49	38	46	.77	+.5	6	5,237	w.	27	w.	14	17	4	9	3.6	0.0	0.0
Tonopah	6,090	12	20	------	------	------	68.8	------	94	21	82	36	4	56	34	48	29	27	.14	------	1	-------	w.	----	------	---	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.57	29.88	.00	66.8	+4.0	103	22	84	36	2	50	49	50	38	46	.41	−.3	6	5,338	sw.	27	s.	24	16	8	6	3.9	.0	.0
Modena	5,473	10	46	24.58	29.79	−.03	67.5	+4.2	98	20	86	36	5	49	44	48	30	32	.12	−.2	2	8,142	sw.	35	sw.	7	17	8	5	3.3	.0	.0
Salt Lake City [1]	4,337	86	210	25.66	29.83	−.02	70.4	+3.0	101	20	85	42	9	56	43	55	44	47	1.81	+1.0	8	6,795	se.	37	w.	24	11	12	7	4.6	.0	.0
Grand Junction	4,602	60	68	25.33	29.83	.00	75.8	+4.4	103	20	90	43	1	62	35	55	39	34	.74	+.3	9	5,586	se.	36	sw.	15	14	10	6	4.0	.0	.0
Northern Plateau							66.8	+3.2										52	1.44	+0.4										5.2		
Baker	3,471	48	53	26.42	29.96	+.01	61.6	+3.0	99	22	75	39	9	48	47	52	44	63	1.60	+.3	11	4,026	n.	29	w.	24	10	7	13	5.6	.0	.0
Boise	2,739	79	87	27.09	29.90	−.01	69.2	+3.9	104	22	82	47	8	56	42	56	46	52	1.59	+.7	10	3,945	nw.	21	se.	3	15	6	9	4.4	.0	.0
Pocatello	4,477	60	68	25.44	29.87	.00	67.2	+5.0	98	22	81	36	9	54	44	52	39	45	1.03	−.1	9	5,846	se.	27	sw.	18	12	9	9	4.6	.0	.0
Spokane	1,929	101	110	27.90	29.91	−.03	65.5	+2.7	97	22	77	46	3	54	41	54	44	53	2.33	+1.0	8	5,091	s.	21	s.	14	9	10	11	5.6	.0	.0
Walla Walla	991	57	65	28.85	29.91	−.05	69.8	+3.3	103	22	81	49	3	58	36	56	46	51	.88	−.2	11	4,033	s.	21	w.	15	10	9	11	5.4	.0	.0
Yakima	1,076	58	67	28.77	29.91	------	67.8	+1.4	100	22	80	48	18	56	34	55	44	49	1.21	+.6	9	4,777	nw.	25	w.	13	10	7	13	5.8	.0	.0
North Pacific Coast Region							61.8	+3.4										74	3.65	+1.3										6.6		
North Head	211	11	56	29.78	30.00	+.01	58.1	+3.3	77	13	62	50	2	54	22	56	53	85	4.28	+2.0	15	9,603	nw.	56	se.	16	7	4	19	6.9	.0	.0
Seattle	125	90	321	29.83	29.96	−.04	63.2	+4.2	81	22	71	50	19	55	24	56	51	70	2.77	+1.4	11	5,889	se.	47	sw.	16	8	10	12	6.0	.0	.0
Tatoosh Island	86	10	54	29.88	29.98	−.04	57.7	+4.7	66	20	62	51	3	54	14	55	53	86	5.93	+2.7	16	7,278	s.	45	s.	17	4	10	16	6.9	.0	.0
Medford	1,329	29	58	28.54	29.93	------	65.8	------	94	21	80	42	18	52	41	55	48	64	.86	+.1	7	-------	nw.	----	------	---	13	8	9	----	.0	.0
Portland, Oreg	153	68	106	29.81	29.96	−.08	65.2	+2.8	85	21	74	51	18	56	28	58	53	70	2.43	+.9	12	4,464	nw.	21	w	14	5	9	16	6.7	.0	.0
Roseburg	510	45	76	29.43	29.97	−.06	64.7	+2.2	87	21	76	45	28	53	37	57	52	69	2.02	+.9	9	3,475	n.	17	nw.	14	6	10	14	6.4	.0	.0
Middle Pacific Coast Region							66.9	+2.6										64	0.90	+0.4										4.3		
Eureka	62	73	89	29.95	30.02	−.03	59.8	+5.5	75	14	65	49	26	54	19	56	54	84	1.34	+.6	6	5,851	n.	24	sw.	15	7	11	12	6.1	.0	.0
Redding	722	20	34	------	------	------	73.8	−1.3	104	22	85	51	7	62	34	57	45	43	1.69	+.9	5	5,803	nw.	31	w.	17	15	4	11	4.6	.0	.0
Sacramento	66	92	115	29.80	29.87	−.02	72.4	+3.0	105	21	87	50	1	58	42	58	49	53	.27	+.1	3	5,068	sw.	19	sw.	2	20	6	4	2.8	.0	.0
San Francisco	155	211	132	29.76	29.93	−.03	61.7	+3.2	78	11	68	52	25	56	22	56	52	76	.28	+.1	4	7,134	w.	26	w.	9	17	6	7	3.7	.0	.0
South Pacific Coast Region							70.3	+1.6										64	0.07	0.0										3.3		
Fresno	327	97	105	29.51	29.86	+.01	76.5	+.7	106	23	91	50	1	62	38	59	45	41	.01	−.1	1	5,816	nw.	21	sw.	23	18	6	6	3.0	.0	.0
Los Angeles	338	159	191	29.52	29.88	−.02	69.0	+2.6	90	26	78	53	4	60	24	61	57	71	.20	+.1	3	4,207	sw.	16	w.	1	19	9	2	2.6	.0	.0
San Diego	87	62	70	29.79	29.88	−.04	65.3	+1.4	75	25	70	56	4	60	17	61	58	81	.01	.0	1	5,196	w.	17	w.	3	13	13	4	4.4	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.89	29.98	------	81.3	+1.6	90	1	87	73	25	76	14	----	----	----	3.43	−1.9	16	7,195	e.	27	e.	23	1	25	4	5.8	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	------	------	------	----	----	---	---	---	---	---	---	---	---	---	---	------	------	---	-------	---	----	------	---	---	---	---	----	----	----
Cristobal	36	6	97	------	------	------	----	----	---	---	---	---	---	---	---	---	---	---	------	------	---	-------	---	----	------	---	---	---	---	----	----	----
Alaska																																
Fairbanks	454	11	87	------	[2] 29.92	------	62.6	------	88	17	74	40	4	51	35	----	----	64	.67	------	7	4,491	sw.	32	sw.	18	7	13	10	----	.0	.0
Juneau	80	96	116	[2] 29.83	[2] 29.92	------	60.4	------	80	8	69	44	14	51	32	52	45	63	.54	------	9	4,256	s.	25	se.	17	11	6	13	5.8	.0	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 30.00	[2] 30.04	------	76.6	.0	83	22	81	70	9	72	12	69	66	72	.72	−.2	10	6,943	e.	23	e.	26	9	12	9	5.4	.0	.0

[1] Observation taken at airport.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, June 1936*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Ft.	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99				48.7		55.5	42.0	63	36	3.54		0.0
Sydney, Cape Breton Island	48	29.85	29.90	−0.05	59.7	+4.3	70.7	48.7	81	37	3.71	+0.48	.0
Halifax, Nova Scotia	88	29.67	29.77	−.18	58.8	+1.1	65.5	52.0	78	44	3.39	−.37	.0
Yarmouth, Nova Scotia	65	29.79	29.86	−.09	58.0	+3.0	65.3	50.7	80	44	4.63	+1.70	.0
Charlottetown, Prince Edward Island	38	29.80	29.84	−.08	60.5	+3.1	69.2	51.8	80	44	2.09	−.58	.0
Chatham, New Brunswick	28	29.74	29.77	−.12	61.4	+1.4	72.5	50.3	86	40	5.36	+1.90	.0
Father Point, Quebec	20												
Quebec, Quebec	296												
Doucet, Quebec	1,236												
Montreal, Quebec	187	29.68	29.88	−.06	65.4	+.5	74.2	56.6	86	43	2.88	−.65	.0
Ottawa, Ontario	236												
Kingston, Ontario	285												
Toronto, Ontario	379	29.50	29.90	−.07	64.9	+1.5	75.0	54.8	87	48	2.91	+.11	.0
Cochrane, Ontario	930												
White River, Ontario	1,244												
London, Ontario	808				62.5		74.4	50.6	87	38	3.11		.0
Southampton, Ontario	656												
Parry Sound, Ontario	688												
Port Arthur, Ontario	644												
Winnipeg, Manitoba	760	29.09	29.91	+.02	60.8	−1.4	72.8	48.9	92	33	2.41	−.88	.0
Minnedosa, Manitoba	1,690												
Le Pas, Manitoba	860				56.9		68.0	45.8	88	36	1.67		.0
Qu'Appelle, Saskatchewan	2,115	27.66	29.88	+.01	58.5	−1.4	71.1	45.8	95	29	3.24	−.18	.0
Moose Jaw, Saskatchewan	1,759												
Swift Current, Saskatchewan	2,392												
Medicine Hat, Alberta	2,365	27.44	29.88	+.03	64.8	+2.8	76.5	53.1	104	36	1.52	−1.24	.0
Calgary, Alberta	3,540	26.31	29.93	+.09	57.5	+1.5	68.9	46.1	94	34	1.47	−.98	.0
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450												
Battleford, Saskatchewan	1,592												
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262	28.61	29.87	.00	66.6	+2.8	79.3	53.9	101	44	1.95	+.53	.0
Victoria, British Columbia	230												
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				56.8		62.4	51.2	70	46	9.03		.0
Prince Rupert, British Columbia	170				55.0		62.9	47.2	77	43	4.09		.0
St. George's, Bermuda	158		30.02	−.10	76.0	+1.6	80.6	71.3	83	68	2.39	−2.54	.0

TABLE 3.—*Severe local storms, June 1936*

[Compiled by Mary O. Souder from reports submitted by Weather Bureau officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Pottawattamie, Cass, Adair, Polk, Harrison, and Clinton Counties, Iowa.	1				$14,000	Thundersqualls and hail.	Trees and poles torn out; live wires blown down halting traffic; many buildings unroofed and smaller ones destroyed.
Indianapolis, Ind	2	5:49-midnight				Thundersquall and excessive rain.	Storm of considerable intensity; damage to telephone and power lines; branches of trees and signs blown down; many basements flooded.
Detroit, Mich., and vicinity	2	P. m.	1,200	2	30,000	Wind, rain, and electrical.	Trees blown down and uprooted bringing down telephone and electric wires; windows broken, signs blown down. Crane blown over causing the death of a man; woman killed by lightning; traffic interrupted because of debris.
Springfield, Mo., and vicinity	2	do		0	50,000	Tornado and hail.	Wind of 50 miles an hour reported at 6:15 p. m. All windows in one greenhouse broken and hundreds of plants and flowers ruined. 5 miles east of the city hailstones were as large as billard balls. While the storm was raging over the southeastern part of the city, at 6 p. m., a terrific roar overhead was heard—the tornado passing over, not seen because of clouds. Skies were clear to the west with sun shining over the western part of the city. Over a small area hail ruined crops and gardens.
Vienna, Ill	2					Wind	Damage to trees, apple orchards, and buildings.
Cuyahoga County, Ohio	2				30,000	Thundersquall	Several buildings unroofed, walls blown down, and windows broken.
Morgan, Limestone, and Madison Counties, Ala.	3		[1] 10		95,000	Wind, hail, and dust.	Winds caused dust storm over the northeastern section of the State, north of Birmingham. $15,000 damage from hail in extreme southeastern and southwestern sections of Limestone and Madison Counties.
Rawlins, Wyo	4	Noon			2,500	Hail and wind	Storm passed over the State Fair Exhibition shows, blowing over tents and causing other damage.
Amistad, N. Mex	4	12:30–1:30 p. m.	[1] 3			Heavy hail	Gardens damaged; some lambs killed.
Rockingham County, Va., southern portion.	4	1 a. m.	[1] 1		50,000	Hail	Wheat, corn, and gardens slashed to shreds; loss to fruit crop; property damaged $2,000; crop loss $48,000.
Norfolk, Va	4	1:10–4:15 p. m.			500	Thunderstorm	Damage by lightning.
Oakwood, Okla	4	2–3 p. m.	2,640		5,000	Hail	Loss to crops; path 5 miles long.
Watonga, Okla	4	3 p. m.			28,000	do	Crop loss $25,000; other losses $1,000.
Spencer, Okla	4	3–4 p. m.	[1] 4		5,000	do	Damage to crops; path 10 to 12 miles long.
Minco and Union City, Okla	4	5–6:20 p. m.	[1] 7		162,100	do	Length of path 11 miles covering 77 sections of farm land; crop loss $154,000; other losses $8,100.
Camargo, Okla., west of	4	P. m.	[1] 3		500	do	Loss to wheat crop; path 6 miles long.
Okeene and Waukomis, Okla	5	4–7 a. m.	[1] 2–4		62,500	Severe hail	Gardens at Waukomis completely destroyed and wheat fields totaling about 7,500 acres damaged with loss to wheat crop of $50,000; property damage $10,000. In Okeene crop loss of $2,500 reported. Path of storm 25 miles long.

[1] Miles instead of yards

TABLE 3.—*Severe local storms, June 1936*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Caldwell to South Haven, Kans., vicinity of.	5	6:30 a. m.	[1]3		6,000	Wind and hail	Property damage $2,000; crop loss $4,000; path 10 miles long.
Hastings, Okla., vicinity of	5	9:30 a. m.	[1]4-5	3	50,000	Tornadoes	A series of 3 tornadoes struck in this vicinity; 5 persons were injured; buildings destroyed; loss to crops; path 20 miles long.
Ford, Hodgeman, and Edwards Counties, Kans.	5	1 p. m.	100	0	2,000	Tornado	Originated 6 miles north of Spearsville and disappeared north of Kinsley. Damage confined to rural districts. 1 large and 4 smaller tornado clouds observed; path 25 miles long.
Stafford County, Kans., vicinity of.	5	2:30 p. m.	[1]4	0	200	do	Only 1 farm struck; path 4 miles long.
Enid, Okla	5	3-3:30 p. m.	[1]2		7,100	Hail	Property damage $700; crop loss principally to wheat, $6,400; path 6 miles long.
Elk City, Okla., and vicinity	5	3-4 p. m.	[1]3-4		25,000	do	Loss to crops $20,000; property damage $5,000; path 10 miles long.
Corn, Okla	5	5 p. m.		1	2,000	Tornado	House demolished; path about 1 mile long.
Snyder (near), Okla	5	5:30 p. m.	75	1	26,000	Tornado and hail	1 person injured, 20 cows and several horses killed; several buildings demolished; crop loss $18,000; property damage $8,000; path 6 miles long.
Painter, Okla	6	6 p. m.	[1]1	0	297,000	do	Many homes destroyed and more than 100 persons left homeless; crop loss $250,000; property loss $47,000; path 5 miles long.
Kay County, eastern portion, and Osage County, western portion, Okla.	5	6-7 p. m.		1	200,000	Wind	11 persons injured; many buildings near Pleasant View and several at Burbank destroyed or badly damaged; a brick building collapsed.
Lawton, Okla	5	6-8 p. m.	[1]2		298,000	Hail	Crop loss, $250,000; property damage, $48,000; path, 7 miles long.
Jefferson County, Okla., extreme northwestern portion.	5	10 p. m.	[1]2-3	2	100,000	Probable tornado	8 persons injured and 45 homes demolished; several brick buildings in Waurika including the school building and hospital damaged; loss to livestock, poultry, and crops; path, 20 miles long.
Antlers, Okla., vicinity of	6	12:45 a. m.	880	0	1,400	Tornado	Crop loss, $400; property damage, $1,000; path, 20 miles long.
Carnegie, Okla	6	6 p. m.	[1]2		13,000	Hail	Property loss, $3,000; crop loss, $10,000; path, 4 miles long.
Bartlesville, Okla	6	6-8 p. m.	[1]3		8,200	do	Crop loss, $7,000; property damage, $1,200; path, 12 miles long.
Chattanooga to Walters, Okla., and vicinity.	6	4:30-9 p. m.			250,000	Wind, rain, and hail.	About 25 homes, mostly in rural districts, completely wrecked and many others damaged; several persons killed and dozens left homeless; prospective crops of cotton and grain a total loss in some areas; heavy loss of livestock and property.
Grandfield, Okla., vicinity of	6	8:30 p. m.	880	0	23,000	Tornado	Loss to crops, $15,000; property damage, $8,000.
Randlett (near), Okla	6	do		0	500	do	Slight property damage over a small area.
Toledo, Ohio	6	9:35-9:55 p. m.				Thundersquall	Several buildings struck by lightning; trees damaged.
Adamsville, Ga	6			1		Electrical and wind.	3 persons injured and small house demolished.
Fairmont to Omaha, Nebr., and vicinity.	6	A. m.		0		Tornado	Most damage in Central City, Schuyler, Silver Creek, Fairmont, and Columbus. Basements flooded and traffic interrupted; power lines down; roofs damaged. In Valley, Nebr., high-school regiment forced to leave camp when their tents were blown over.
Payette and Canyon Counties, Idaho.	7	12-12:20 p. m.	[1]25		55,000	Heavy hail	Considerable damage to truck gardens, fruit, and crops.
Rubens, Idaho, 4 miles north	7	12:30 p. m.	67	2	4,250	Tornado	House and barn on a ranch completely demolished; few trees uprooted; all water from a small pond sucked out. Storm followed by heavy rains and hail which damaged crops in small area.
Toms Brook, Va	7	1 p. m.			7,000	Electrical	Church struck by lightning and burned; path narrow.
Craighead County, Ark., eastern portion.	7				50,000	Heavy hail	Loss to crops.
Memphis, Tenn	7					Thundersquall	Several thousand dollars' damage to property and power lines.
Batesville, S. C., and vicinity	8	7-8 p. m.			5,000	Hail and wind	Much damage to growing crops and fruit immediately west of Batesville. In Batesville, hail driven by strong wind was banked to a depth of from 11 to 12 inches. Little property damage reported. Many trees stripped of leaves.
Sterling, Colo	8	P. m.	[1]4			Heavy hail	Loss to crops; small grains total loss in some sections; heavy losses.
Lake Manitou, Ind	8				2,500	Wind and hail	Property damage.
Minneapolis and St. Paul, Minn.	8				1,000	Thunderstorm	Number of buildings and trees struck by lightning; power lines temporarily disrupted.
Pittsburgh, Pa	8			2		Electrical	Storm severe; no details.
Macon, Coffee, and Geneva Counties, Ala.	8-9				110,000	Wind and hail	Property damaged.
Omaha, Nebr	9	8:30-8:40 a. m.				Wind, rain, and hail.	During this severe storm, total darkness enveloped the city; damage amounting to several thousand dollars to windows, basements, poles, wires, etc.
Council Bluffs southeastward through Shenandoah, Creston, Des Moines, and Humboldt, Iowa, and vicinity.	9	8:30-11:30 a. m.		1	100,000	do	Storm moved in from Nebraska in the early morning; D. W. Morehouse, astronomer and president of Drake University, said the sky at 11 a. m. was the darkest he had ever seen in daytime except a total eclipse of the sun. Artificial illumination necessary outdoors. First spot reporting the sudden inky blackness was Council Bluffs, at 8:30 a.m. Telephone and electric wires down. Considerable damage to small, scattered areas where hail was heavy. Boy electrocuted when the handle bar of his bicycle came in contact with a live wire that had blown down.
Vahnora, N. Mex	9	4 p. m.	[1]3			Heavy hail	Orchards, gardens, and roofs damaged.
Miami, N. Mex	9	4:15 p. m.	[1]5		10,000	do	Orchards, gardens, and hay destroyed; roofs damaged.
Julesburg, Colo	9	11:47-11:57 p. m.	[1]2			Hail and wind	Small grains total loss; beets and corn severely damaged; truck gardens and one crop of alfalfa total loss; trees stripped of all leaves; small buildings, windows, shingles, and paint badly damaged; many thousands of dollars' loss.
Alamosa, Colo	10	1-5 p. m.	[1]3-4		500	Hail	Only small area covered by storm planted in crops or loss would have been greater.
Hermanas, N. Mex	10	4 p. m.				Heavy hail	Gardens damaged; poultry killed.
Helena, Ark	10				1,000	Winds	Damage to roofs, signs, windows, and trees.
Drummond, Tenn., and vicinity.	10			2		Wind, rain, and dust.	Electric and communication lines disrupted; houses unroofed and trees blown down; thousands of dollars' damage reported.
Laguna, N. Mex	11	3 p. m.	2,640			Heavy hail	Severe damage to gardens.
Lake Pontchartrain, La., and vicinity.	11	P. m.				Wind	Wind velocity of 53 miles per hour recorded at 9 p. m., at the Shushan Airport; 4 persons rescued from an overturned sloop; eatboat wrecked, other damaged; trees uprooted in Lakeview; electric service interrupted.
Punxsutawney, Pa	12	8-8:30 p. m.			55,000	Hail and wind	House unroofed; other minor property damage $5,000; crop loss $50,000. Hail drifted to depth of over 1 foot.
Pittsburgh, Pa., and vicinity	12					Thunderstorm and hail.	Hailstones piled nearly 6 feet high in gullies the next morning and despite several days of sunshine, mounds measuring more than 3 feet high still remained on the 16th. Heavy crop loss; automobile tops punctured.
Adams County, Pa., eastern portion.	13	1-3 a. m.	[1]3		300,000	Hail and wind	One of the worst storms to visit this section; heaviest in Abbottstown, East Berlin, and Orrtanna. Many large trees uprooted; several small buildings unroofed or otherwise damaged; telephone and telegraph lines out of commission. Hail piled in places to depth of over 18 inches, remained for 24 hours. Many farms denuded of growing crops; hundreds of chickens and small livestock killed.
Lyon, Yellow, and Medicine Counties, Minn., northern portion.	13	8:30 p. m.			50,000	Hail	Severe damage to growing crops; 60 percent of flax ruined; windows broken.

[1]Miles instead of yards.

TABLE 3.—*Severe local storms, June 1936*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Watertown, N. Y., southern section.	13	P. m.		0		Tornado	Force of tornado entirely spent in about a minute. A 35-pound steel lawn table, at the rear of a residence, lifted from a pole running through the center of it and carried 40 feet, crashing into the side of the garage. A steel spring chair lifted into the air 10 feet, cutting a clothes line, was blown against the side of the house.
Portland, Oreg., and vicinity	14	3:07 p. m.				Thundersquall	Storm more severe east of Portland where heavy rain and hail flooded buildings in Park Rose; lower section of the highway east of Portland covered with water to the depth of 2 feet; traffic interrupted; gardens damaged; cherries ruined.
Upper Pogue Flat, Wash.	14					Hail	Loss to apple crop.
Fort Myers, Miami, Fla.	15	8–8:30 a. m.		1		Torrential rains	More than 8 inches of rain in places causing much flooding in lowlands near the storm path. Highways flooded south of the Fort Myer-Lake Okeechobee section, and several towns including Bonita Springs, Estero, Immokalee and LaBelle were so badly flooded as to necessitate evacuation or removal to the second stories with consequent water damage to furniture and merchandise; livestock drowned; considerable damage to fields, gardens and highways. Railroad track into Immokalee washed out and bridges near LaBelle down.
Paradise, Mont., vicinity of	15	12:15–12:30 p.m.				Hail	Considerable damage to gardens and fruit.
Rice, Goodhue, Dakota, Washington, Wabasha and Winona Counties, Minn.	16	3 p. m.				Hail and rain	Ground covered to a depth of more than 2 inches. Heaviest hail occurred in the vicinity of Red Wing and Hastings, Minn., where growing crops were damaged severely, many acres being a total loss. Windows broken and automobile tops punctured. Rain beneficial, offsetting to some extent the damage from hail.
Rice, Goodhue, Dakota, Wabasha and Winona Counties, Minn.	16	5 p. m.			25,000	Severe thunderstorm.	1 person injured; several barns, small buildings and silos wrecked; many trees uprooted; power lines down; small boats torn from their moorings; much poultry perished; loss to crops.
Okmulgee, Okla.	16	5:30 p. m.			10,000	Wind	Small crop loss; amount given property damage.
Douglas, Todd, Stearns and Morrison Counties, Minn.	16	6–8 p. m.	800		15,000	Severe thunderstorm.	1 person injured; number of barns, outbuildings, windmills, and silos demolished; other property damaged; wires down and trees uprooted.
Ellsworth County, Kans.	16	7 p. m.	[1] 3		80,000	Heavy hail	Loss mostly in wheat; path 12 miles long.
Pratt, Kingman and Barber Counties, Kans.	16	7–8:30 p. m.	[1] 5–10		300,000	Heavy hail and wind.	Crops in many parts of path total loss. Buildings and automobiles greatly damaged in Medicine, Lodge, and Nashville. Path 55 miles long.
Long Prairie, Minn., vicinity of	16	7:30 p. m.	[1] 6			Heavy hail	Considerable damage mainly to windows; loss to corn crop.
Delaware, Clayton, Williamsburg, Benton, Mitchell, Worth, and Hancock Counties, Iowa.	16				10,000	Wind	Property damaged.
Harlan, Iowa	16				2,000	Heavy hail	No details.
Lincoln, Nebr.	16					Wind and rain	Wind of 48 miles per hour and excessive rain recorded. 7 persons injured. A garage, barn, 3 tourists cabins demolished; considerable damage to communication lines, trees, and windows.
Wausau, Wis., vicinity of	16				5,000	Wind storms	Storms general over west-central and north-central Wisconsin during the evening and night, the greatest loss being in Trempealeau and Jackson Counties. Four barns and a number of smaller buildings blown down.
Milwaukee, Wis.	17	4:08–4:41 p. m.				Thundersquall	Poles and trees blown down. High wind at 4 p. m. carried a cloud of smoke and dust out of the Menomonee Valley.
Toledo, Ohio	17	6:20–6:35 p. m.				do	Several persons injured; automobiles and buildings damaged by falling trees; some wires and poles down.
Cleveland, Ohio	17	8:02–9:10 p. m.				do	Wind blew for 15 minures before rain began, whipping up immense quantities of dust and sand. Several persons in small boats on the lake or near the shore drowned. Number of trees and wires down.
Buffalo, N. Y., and vicinity	17	P. m.		3	2,500	do	Damage caused by lightning; 3 men drowned when their boat capsized while fishing in Lake Erie.
New York State, northern portion.	17				18,000	Electrical	Five barns and a house struck by lightning and burned; 6 cattle in the field killed.
Monroe County, N. Y., northwest portion.	17					Heavy hail	Much damage to fruit, tomato plants, and peas.
Ripley, N. Y., vicinity of	17					Hail	Considerable injury to ripening cherries and tomato plants. Some damage to vineyards.
North Evans, N. Y.	17				10,000	Electrical	Mill, shed, and warehouse destroyed by fire.
Dayton, Ohio, and vicinity	17			1	1,000	Thundersquall	Lightning caused several small fires and a larger one that damaged a church to the extent of $1,000.
Asheville, N. C.	18	12:25–12:50 p. m.			10,000	Thunderstorm and hail.	Business section particularly hard hit; damage mostly to windows, signs, roofs, street lights, and car tops; some damage to gardens. Large hailstones fell over a relatively small area.
Williamstown, Pa.	18	4:45–5:20 p. m.	[1] 8			Hail and wind	Loss to crops; many automobile tops damaged and thousands of window panes broken.
New Jersey	18	P. m.		2		Thunderstorms	A succession of thunderstorms swept across this State. 2 men killed and another burned on the hand when lightning struck a tree under which they were standing. Several other injuries reported. In Camden 7 fires started almost simultaneously caused by lightning. No damage reported in the vicinity of Atlantic City, but wind reached a velocity of 41 miles an hour.
Knoxville, Tenn., and vicinity	18					Thundersquall and hail.	2 persons slightly injured, several barns unroofed and wires blown down. Heavy hail in the Kimberline Heights section.
Marshallville and Fort Valley, Ga., vicinity of.	19			3	60,000	Wind	8 persons injured: property damage $30,000. Loss to peach crop $30,000 over an area 1 to 4 miles wide and 12 to 20 miles long.
Brogdon and Britton, S. C., and vicinity.	20	P. m.			800	Electrical	Property damaged.
Madison (near), Fla.	20				5,000	Heavy hail	Loss in tobacco, corn, and cotton.
Scranton, Pa.	20			1		Torrential rains, electrical.	Much washing of streets and flooding in lowlands.
Cumberland County, Va., northern portion.	21	2–3 p. m.	[1] 1		500	Hail	Loss to crops.
Slick, Okla.	22	4 p. m.	2,640	0	29,000	Tornado and hail.	Several homes damaged and much farm property immediately south of Slick destroyed, leaving many homeless. Loss to crops. Path 6 miles long.
Andarko, Okla., 9 miles southwest.	22	5:30 p. m.	[1] 3		50,000	Hail	Crop loss $50,000. Very little damage to buildings or other property. Path 9 miles long.
Rosedale, Okla.	22	6:45 p. m.	200	1	1,250	Tornado	Property damage $500; crop loss $750. Path 3 miles long.
Tipton and Davidson, Okla., vicinity of.	22	7 p. m.	[1] 2		4,000	Hail	Loss to cotton crop that had to be replanted. Path 6 miles long.
Little Rock, Ark.	22				5,700	Electrical	Damage to power lines and equipment.
Cold Springs, Okla., vicinity of.	23	4:30 p. m.	200	0	850	Tornado and hail.	Several fields of cotton had to be replanted because of hail damage; path 3 miles long.
Blackfoot, Idaho, 5 miles west.	23	6:30–7:30 p. m.	880–1,760		2,000	Wind	Damage to outbuildings on 2 farms; several trees uprooted.
Lemoore, Calif., vicinity of.	24	A. m.				do	Storm struck a ranch, ripped porches off the house, and demolished a large dairy barn. Light showers accompanied the storm.
Baker County, Oreg.	24	P. m.			5,000	Rain, hail, and wind.	Roads filled with debris. Small trees ruined and chickens killed. Vegetable gardens and streets flooded, sewers being inadequate for the large streams of water.

[1] Miles instead of yards.

TABLE 3.—*Severe local storms, June 1936*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Bend, Oreg	24	P. m				Heavy rain	Traffic proceeded with difficulty on the Ochoco Highway over Rock Creek near John Day Junction after a near-cloudburst carried tons of rock and debris from nearby hills.
Quinter, Kans., southwest section.	26	8 p. m	440	0	18,000	Tornado and hail	Numerous outbuildings destroyed; path 2 miles long.
Sioux City, Iowa, and vicinity	26					Wind and rain	Extreme velocity of 74 miles recorded. Trees uprooted or damaged: traffic interrupted.
Assiniboine (near), Mont	27	2–4 p. m	11–33	0	1,125	Tornado and dust	Storm moved northeastward passing north of Havre about 2:30 p. m., destroying a chicken house. Continuing its travel northeastward over barren country to Cherry Ridge about 4 p. m., where it struck a sheep ranch while shearing was in progress. A sheep shed was destroyed, 14 sheep killed and 7 persons injured.
Ironwood (near), Mich	27				10,000	Wind	3 large barns wrecked.
Corpus Christi, Tex., 20 miles north-northeast.	27					Tropical hurricane and thunderstorm.	Storm severe in areas to northeast and east; 40 to 60 percent of crops damaged over an area of 28 square miles. This rainfall more beneficial than the damage was harmful.
Houston, Tex	27					Hurricane	Considerable scattered property damage to frame buildings, small boats, and crops. The disturbance formed on the Gulf of Corpus Christi and was accompanied by torrential rains. At Port Aransas and Ingleside it was estimated the wind reached a maximum velocity of 75 miles.
Warrenton, N. C	28	3 p. m		0	50,000	Tornado	2 large warehouses demolished and several other buildings unroofed or damaged by falling trees.
Ashton (near), S. Dak	28	3:30–4 p. m			5,000	Wind	Property damaged.
Smithfield (near), Va	28	4:30 p. m	[1] 1–2		10,500	Hail	Loss to crops $10,000; property damage $500.
Huron, S. Dak., vicinity of	28	4:39–5 p. m				Wind and rain	Several buildings damaged; branches blown off of trees; loss to vegetable gardens.
Mitchell to Howard, S. Dak., vicinity of.	28	5:30–6 p. m		0		Tornado	Several homes, windmills, elevator, and farm machinery wrecked; path narrow.
La Salle, N. Y., vicinity of	28	P. m		2		Squall	Several canoes overturned in the Niagara River, opposite La Salle, and 2 men drowned.
Belhaven, N. C	28			1		Wind	Small house demolished.
Clinton, Iowa	29	3:15 p. m		1		Tornado	Storm swooped in with a roar cutting 2 trails of destruction, the first track was of short duration coming from the northwest gaining in intensity as it moved eastward across the river. About 10 minutes later another path was cut 880 to 1,320 yards wide, mowing down trees and small buildings. This disturbance first began at Clarinda in the form of a thunderstorm, causing the death of a man by lightning. From Clarinda the storm passed through Rose Hill, Iowa City, Wilton Junction to Clinton. At Wilton Junction the disturbance left twisted debris in its wake reaching Clinton as a well-developed tornado. Thousands of dollars' damage reported.
Lincoln County, Kans., southern section.	29	4 p. m	[1] 4		3,000	Wind	1 person injured; 5 barns destroyed. Path 10 miles long.
Wyandot and Erie Counties, Ohio.	29	P. m				Thundersquall	Number of cattle killed and many buildings damaged.
Aledo, Flora, Galva, La Harpe, and Morrison, Ill.	29					Wind	Damage to small buildings, trees, and power lines.
Fulton, Ill	29				27,000	do	Property damaged. Funnel-shaped cloud reported, but the distribution of debris did not indicate the winds to be of tornadic nature.
Hancock County, Ohio	29				15,000	Thundersquall	Grain elevator destroyed by lightning.
Richland County, Ohio	29				500	do	7 cattle that had taken refuge under a tree killed by lightning.
Alexandria, Minn., vicinity of	30	4 p. m				Severe thunderstorm and hail	A number of barns and small outbuildings destroyed; farmhouse damaged, trees uprooted, some livestock killed, orchards devastated, and growing crops damaged. Farmer seriously injured by flying timber.
Blacksburg to Roanoke, Va	30	4–5 p. m	[1] 3		11,000	Wind	Trees uprooted; power lines down; windows shattered; several barns and silos unroofed. Crop loss $1,000; property damage $10,000.
Jewell County, Kans., northern portion.	30	4–6 p. m	2,200		10,000	Heavy hail	Chief loss in wheat; path 25 miles long.
Burdette, Kans., vicinity of	30	5 p. m	[1] 2		8,000	do	Chief damage to wheat; path 8 miles long.
Cloud Chief, Okla., 1 mile east	30	6 p. m			2,500	Wind	$2,000 crop loss; property damage $500.
Cloud County, Kans	30	8 p. m	[1] 5		1,000	Hail and wind	Loss in wheat; path 7 miles long.
Sweetwater, Tenn	30	P. m			6,000	Thunderstorm	Property damaged in business section of town.
Evansville, Ind., and vicinity	30				3,000	Thundersquall and hail.	Damage to outbuildings, barns, telephones, and power lines and trees.
Paducah, Ky	30			5		Wind	A rowboat capsized and 5 persons drowned.
Richmond, Ashland, and Catlettsburg, Ky.	30					do	Damage to chimneys, signs, awnings, and trees.
Tippecanoe City, Ohio	30					Thundersquall	Many trees down. Traffic had to be rerouted on some highways leading into the city; large barn and brick schoolhouse blown down; awnings blown to shreds.

Late report for May 1936

Boyds to Clarksburg, Md	13		50,000	Hail	Loss to crops.

[1] Miles instead of yards

Chart I. Departure (°F.) of the Mean Temperature from the Normal, June 1936

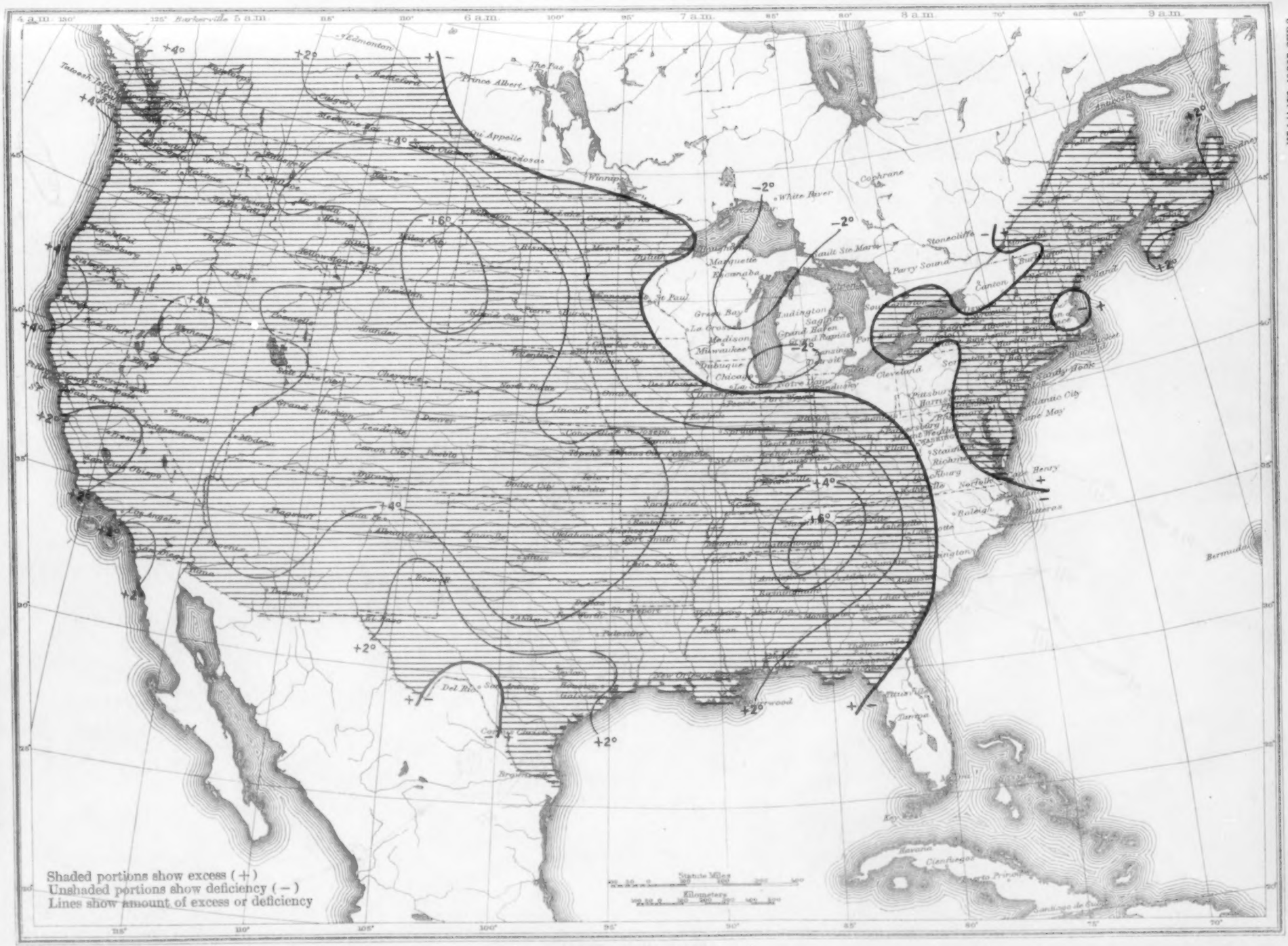
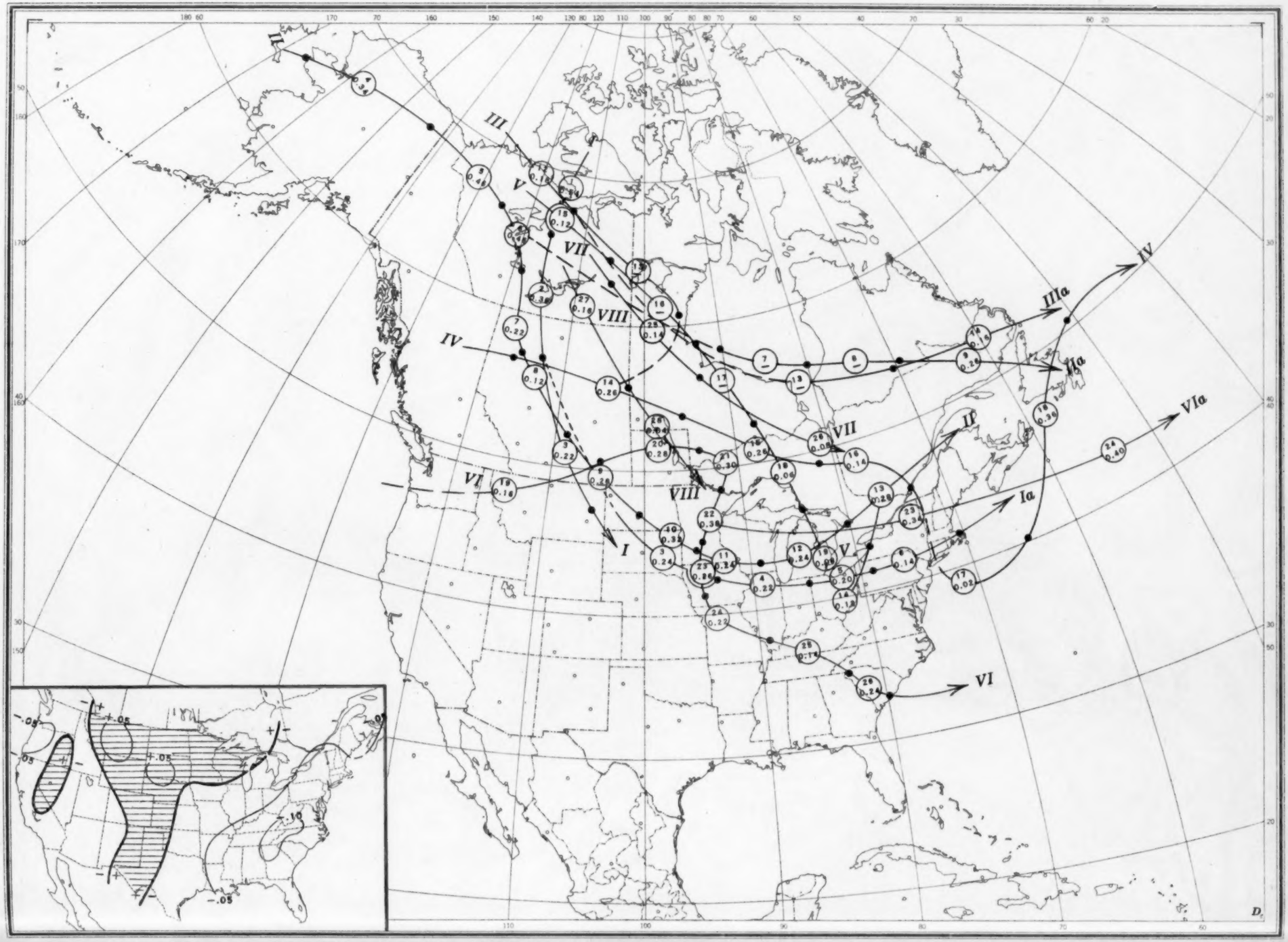

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, June 1936. (Inset) **Departure of Monthly Mean Pressure from Normal**

(Plotted by W. P. Day)



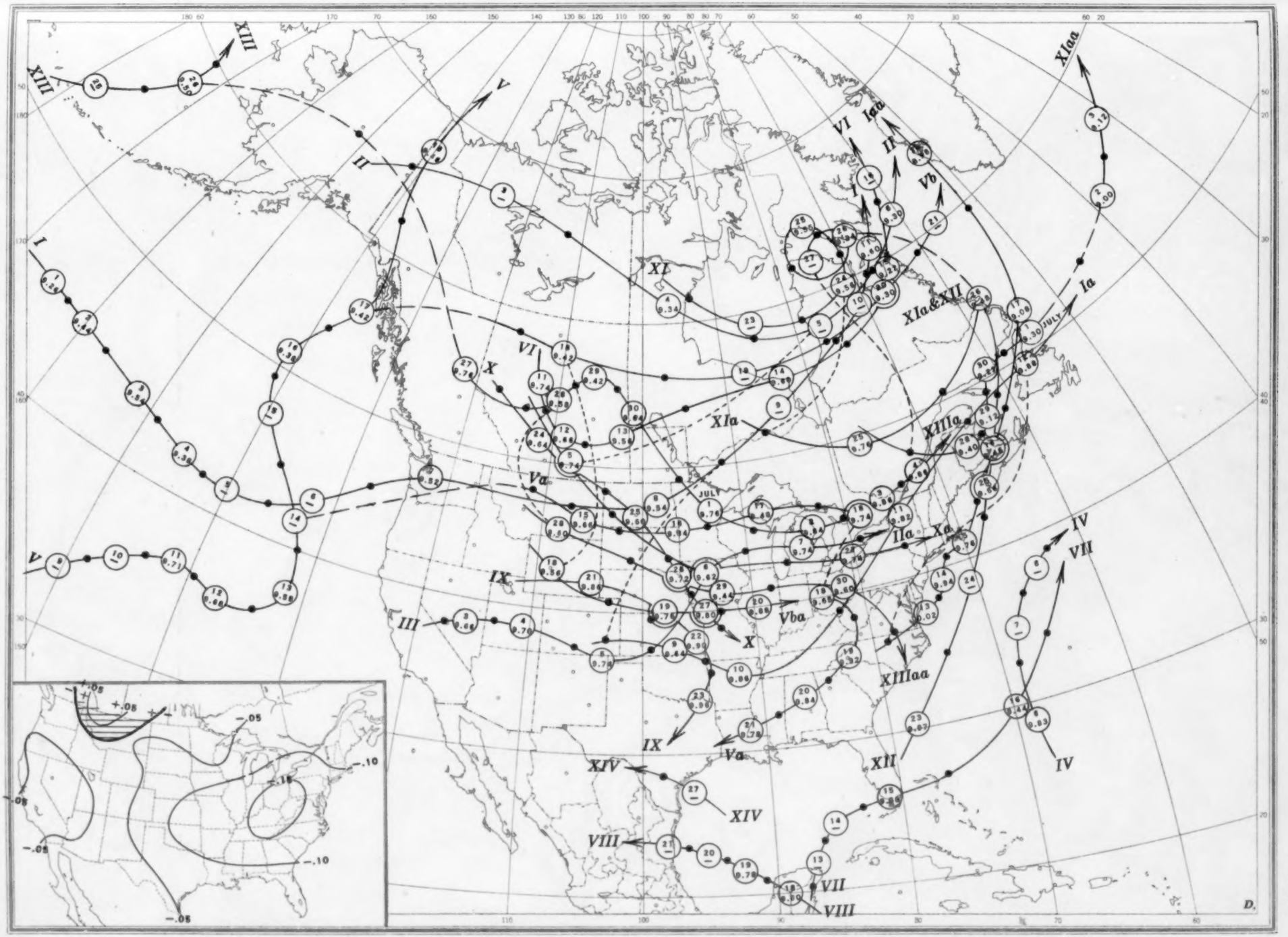
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, June 1936. (Inset) **Change in Mean Pressure from Preceding Month**

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, June 1936. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by W. P. Day)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, June 1936

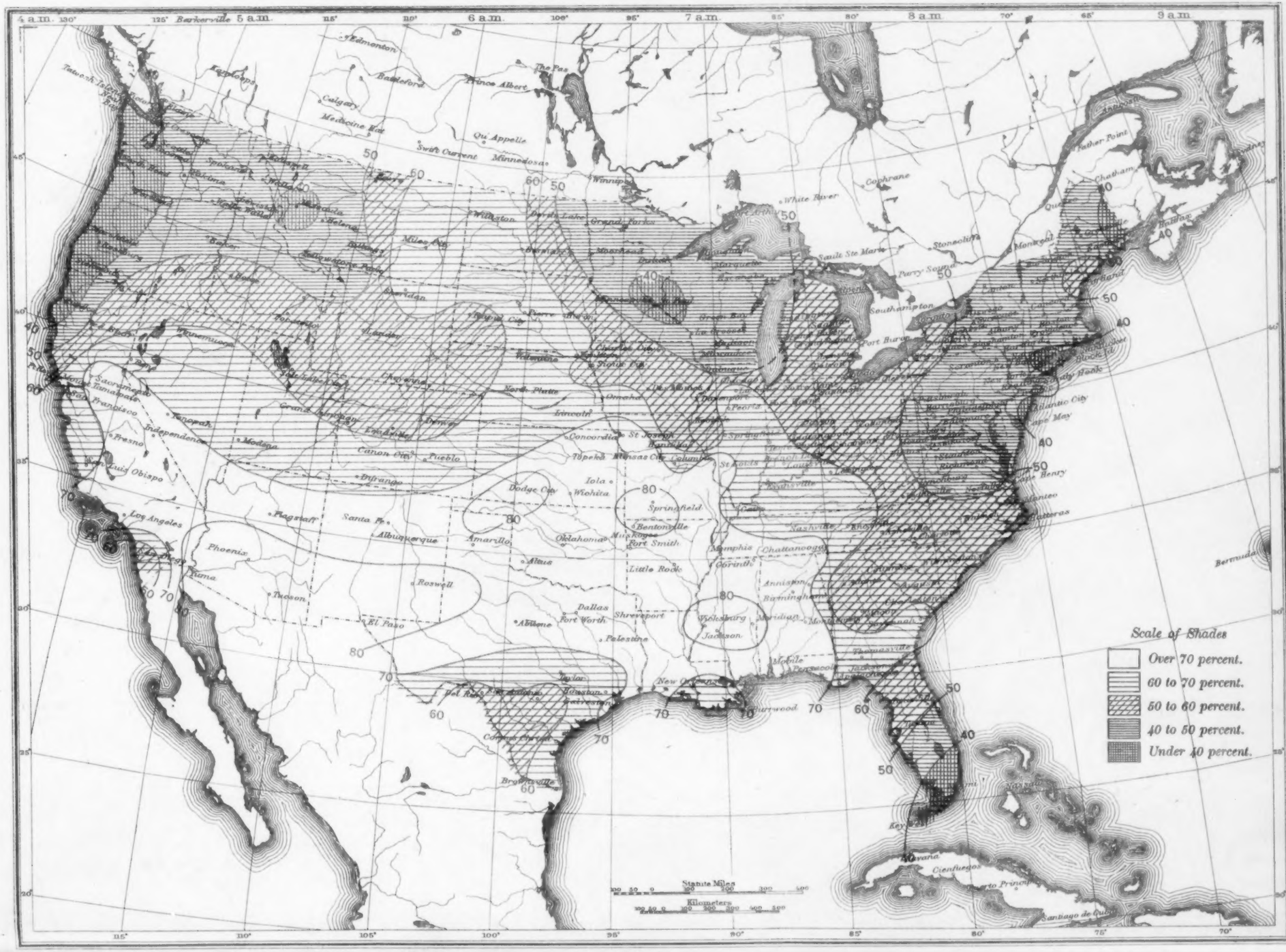


Chart V. Total Precipitation, Inches, June 1936. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, June 1936. (Inset) Departure of Precipitation from Normal

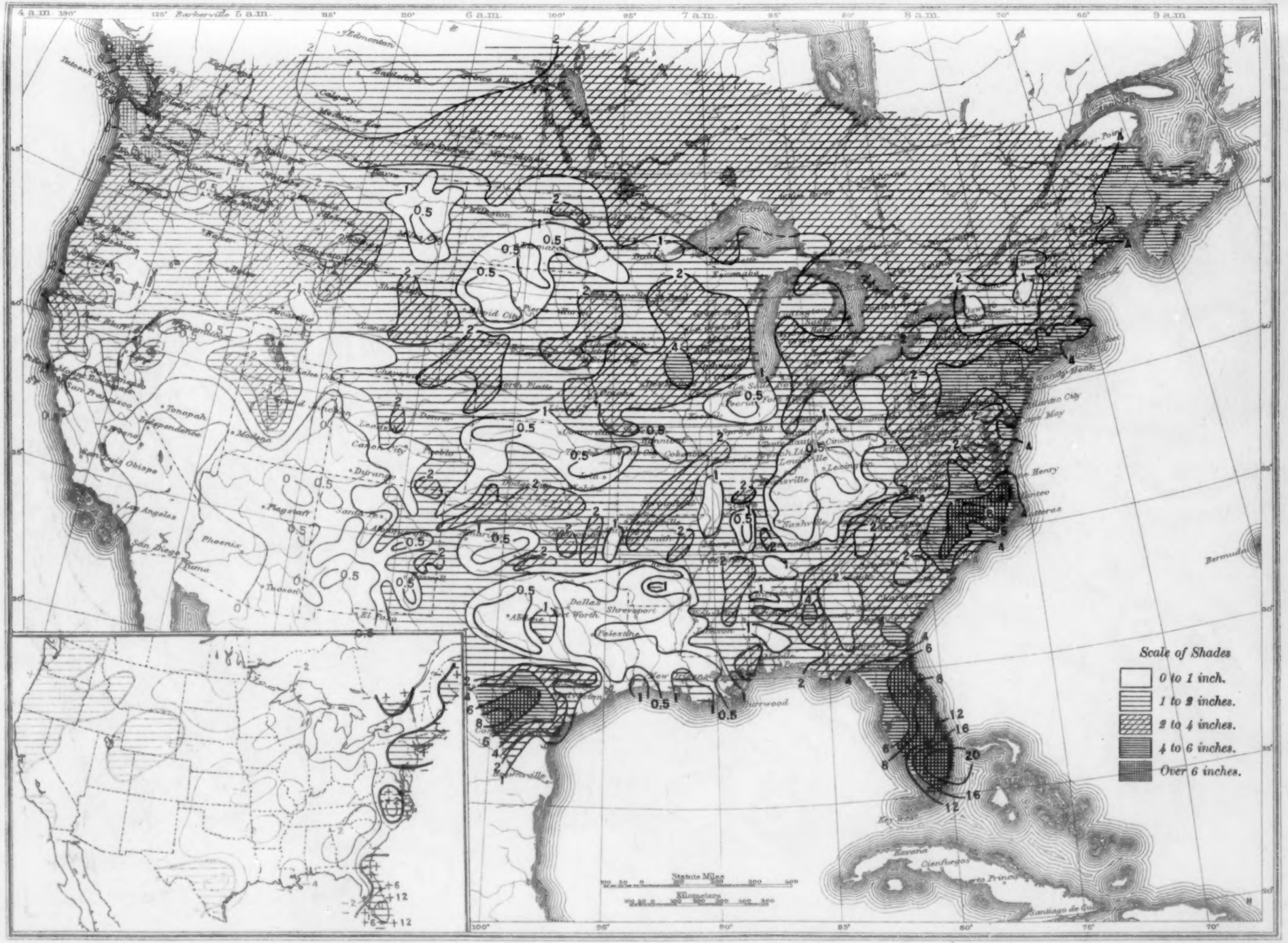
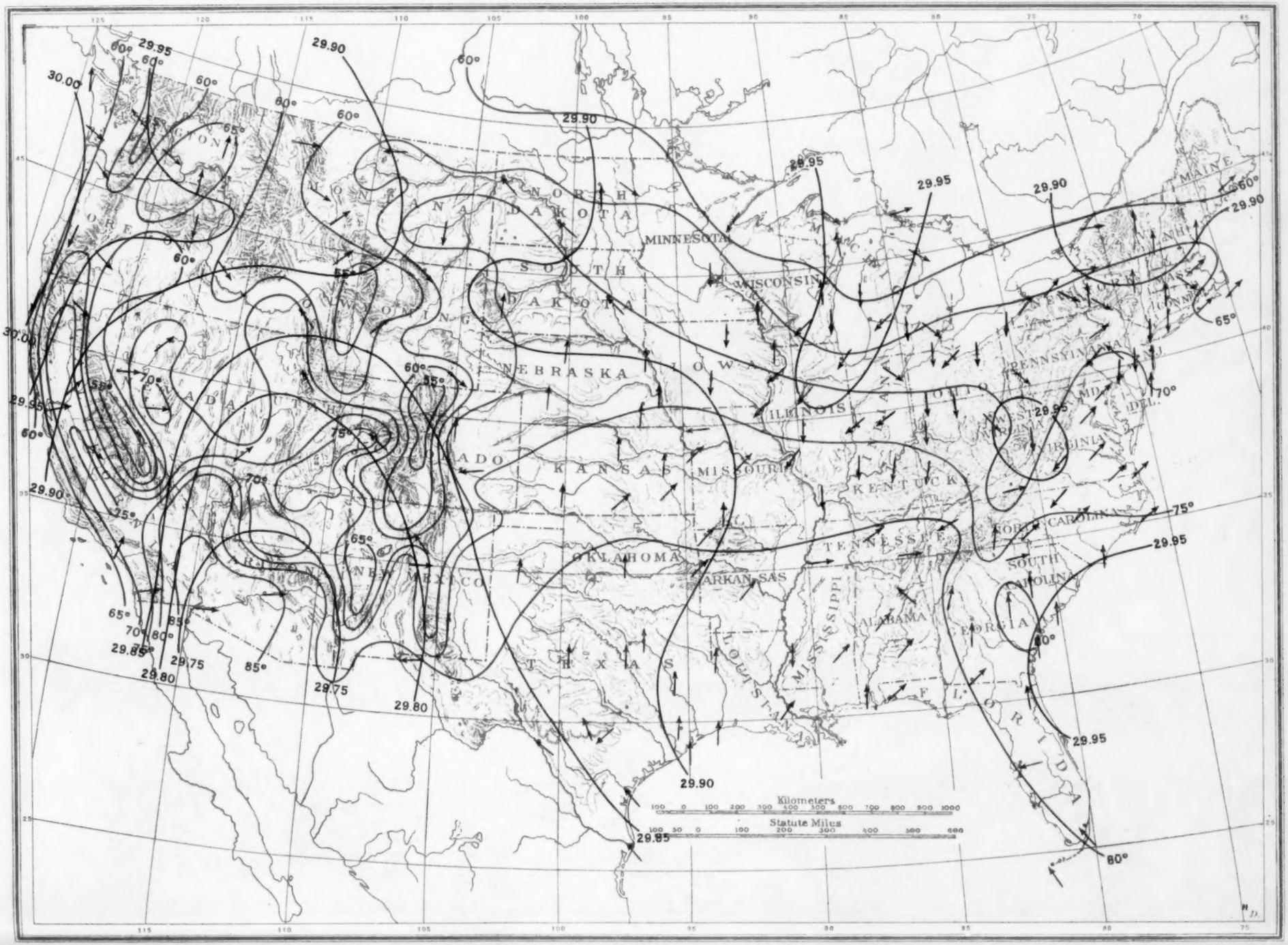


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, June 1936



(Plotted by W. W. Reed)

(Plotted by W. W. Reed)

Chart IX.—Weather Map of North Atlantic Ocean, June 11, 1936

Chart IX. Weather Map of North Atlantic Ocean, June 11, 1936

(Plotted from the Weather Bureau Northern Hemisphere Chart)

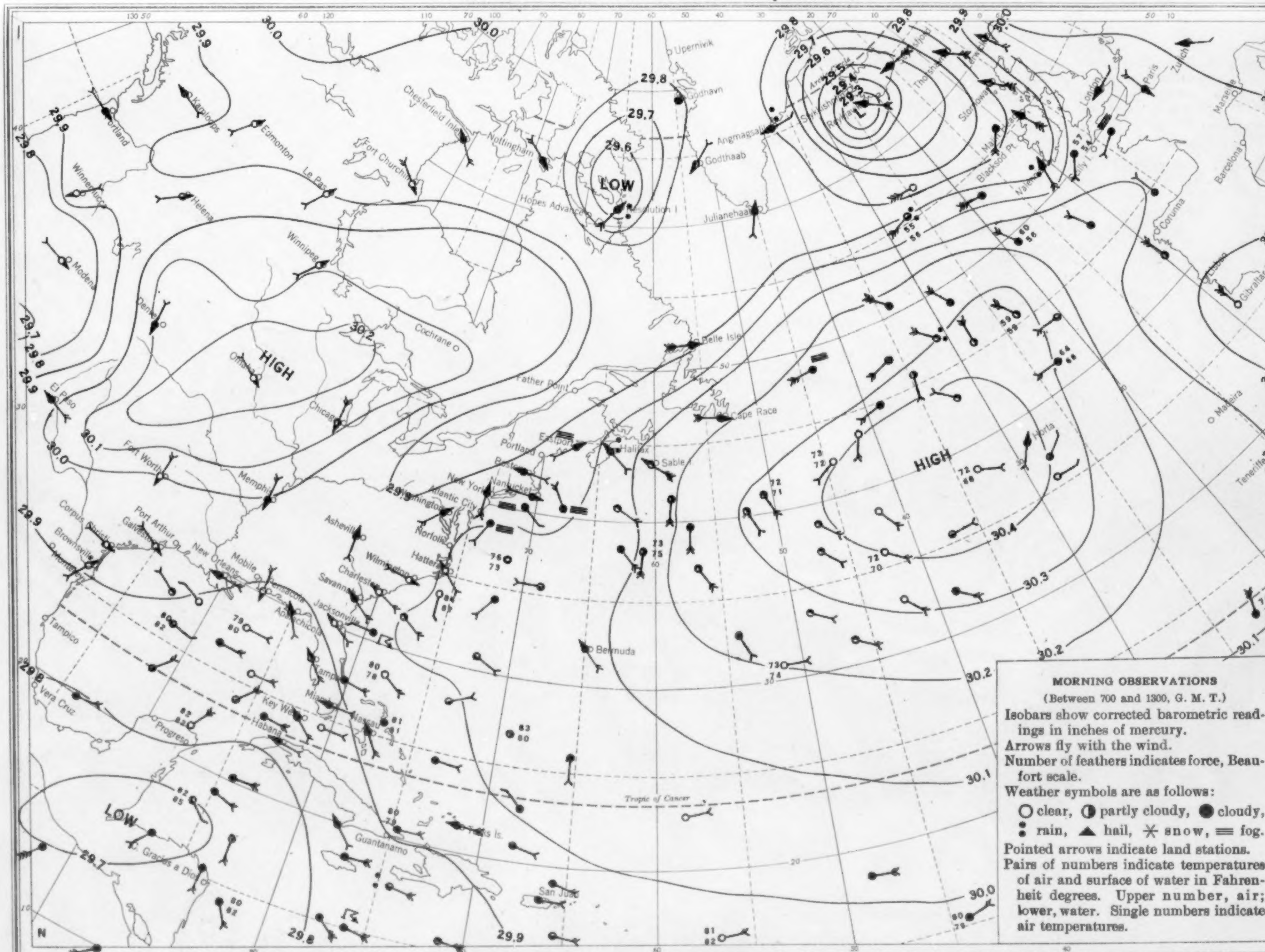
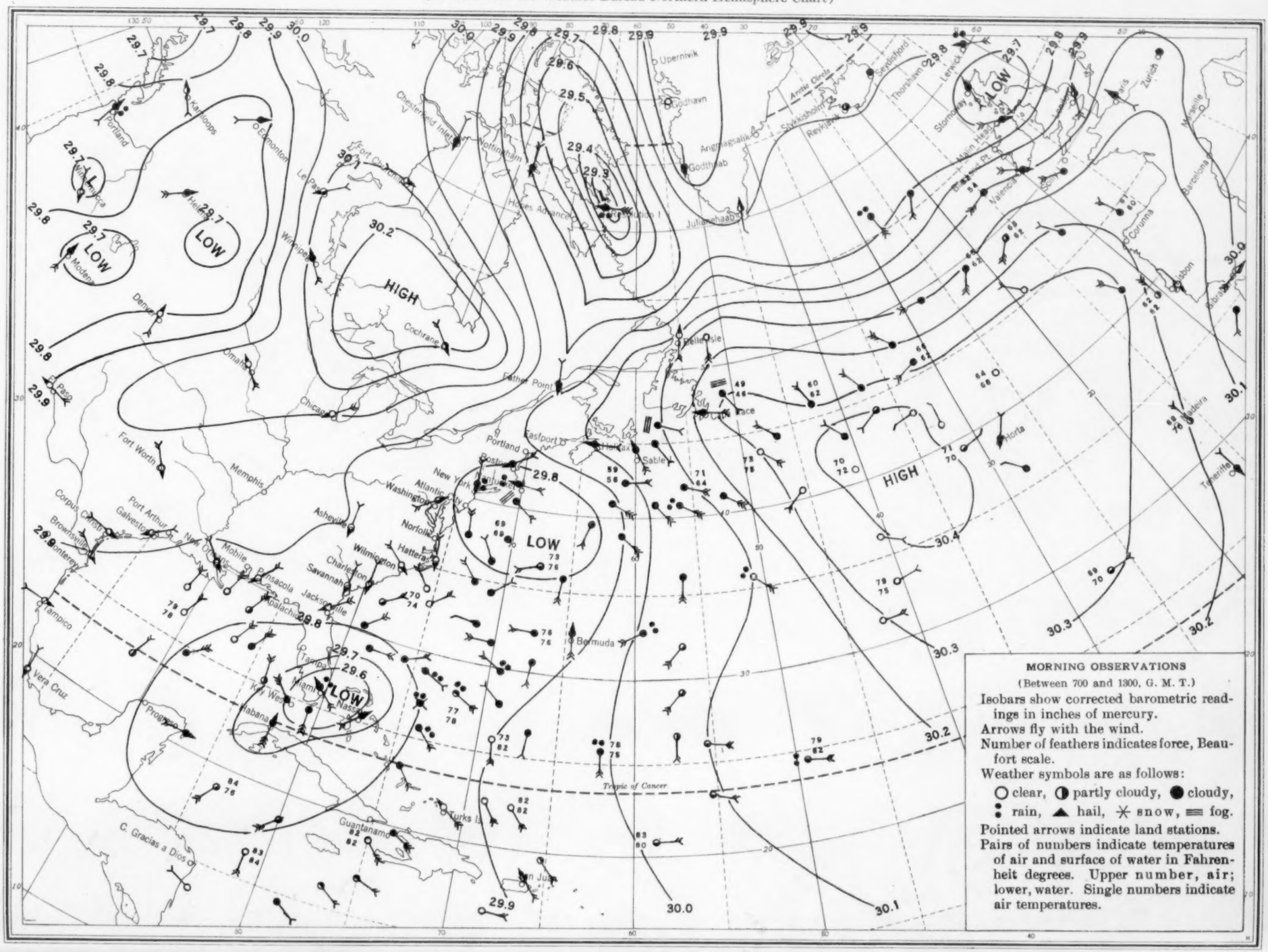


Chart X. Weather Map of North Atlantic Ocean, June 15, 1936

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, 〓 fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.